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ABSTRACT

The first part of this paper on prose analysis explains how structural analysis of text can be used in reading research. This explanation focuses on three methodological uses of prose analysis: (1) the identification of the content and organization of the text for use in a scoring system, (2) the measurement of variations between the text and the reader's comprehension of text, and (3) the identification of a significant dimension on which to characterize text selections to aid in appropriately generalizing research results. The next portion of the paper examines B. J. F. Meyer's approach to prose analysis, including her descriptions of three levels of expository text, treatment of five basic logical relations in exposition, and procedures for building prose-content structures. A detailed comparison is then made of the procedures and scoring systems used by W. Kintsch and by Meyer. The concluding section of the paper examines recent data clarifying discourse types, particularly time-narration and logic-exposition connections and the processing effects of different schemata. (RL)

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Prose Analysis: Procedures, Purposes, and Problems

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PROSE LEARNING SERIES

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Summary of Paper

Specification of the structure of text has three methodological uses in reading research: (1) identification of the content and organization of the text for use in a scoring system, (2) application of the analysis and scoring methods to evaluate variations between the text and the reader's comprehension of it, (3) identification of a significant dimension on which to characterize text selections to aid in appropriately generalizing research results. Reasons for the appearance of different approaches to identifying prose structure are explained in terms of multiplicity of disciplines and specific purposes and to the inherent complexity of text, the writing process, and the reading process (see Figure 1). Meyer's approach to prose analysis is described: three levels of expository text are identified; five basic logical relations in exposition are specified (collection, causal, response, comparison, and description); and procedures for building the prose structure, content structure, are specified (see Appendix, Figures 2-4). A generalized comparison is made between this approach and other procedures; the strengths of each system are specified (see Table 1).

A detailed comparison is made of the analysis procedure and scoring systems used by Kintsch and Meyer. Both approaches yield a hierarchical text structure; the hierarchy is built by repetition of concepts in the Kintsch approach, while it is based on the semantic and logical relations in the text in the Meyer approach. If the superordinate mode for both

approaches is similar, then there will be only minor variations in the hierarchies built by the two different approaches. However, if the superordinate varies (as seen in the third sentence of the analyzed "Saint" text), then there are big variations in the hierarchies. The Kintsch approach requires less analysis time; once the superordinate is selected subgraphs can be simply formed by finding repetition of concepts. The major problem is that selection of the superordinate is intuitive. In contrast, the Meyer approach defines the superordinate idea as the content bound by the top-level structure, the superordinate relation which can subsume under it the remaining ideas of the text. The Meyer analysis requires more training and analysis time (see Figures 3-3).

With regard to scoring (see Figures 5, 6, and protocols), differences result from the different treatment of relationships in the two systems. They are scored separately in the Meyer approach, while they are combined with content in the Kintsch approach. Thus, it is possible to show partial recall and recall of the relationships with inaccurate or omitted content in the Meyer approach. The Kintsch scoring system is more efficient for scoring immediate free recall protocols with close correspondence to text content. The Meyer approach is more time consuming, but more effective with less accurate recall protocols. When studying delayed recall, and recall of older adults, children, and less proficient learners, it would be advantageous for identifying types of differences to utilize the Meyer approach. In addition, the underlying logic processed by learners from expository text is better studied with the latter approach; differences in overall organization of the text and the recall protocol have been reliably studied with this approach.

The preceding sections of the paper show that the extant prose analysis systems satisfy most requirements of the first two methodological uses for prose structure (scoring and comparing variations in text and protocol). However, progress in the clarifying discourse types has only begun. Some data collected by Meyer and Rice are presented which relate to Brewer's (1980) distinction between the time series thrust of narration and the logical thrust of exposition. Differences in type of information recalled and organization of protocols are found when a passage on railroads is processed with narrative schema (history: a collection of events on a time line) or with an expository schema (comparison and related logic) (see Table 2 and Figures 9 and 10). Other dimensions on which to characterize text, such as level and type of detail, were also discussed in the paper.

Prose Analysis: Procedures, Purposes, and Problems

Necessity for Identifying Text Structure

The structure of discourse is the organization which binds it together and gives it an overall organization. This structure shows how some ideas are of central importance to the author's message, which is bound by this overall organization, while other ideas are shown to be peripheral. In expository text, the text structure specifies the logical connections among ideas as well as subordination of some ideas to others. It is this structure of text that primarily differentiates text from simple lists of words or sentences.

Since text structure is an essential characteristic of text, educators and psychologists interested in reading comprehension have sought to describe and classify it. This description is necessary in order to examine how readers identify and utilize text structure in the comprehension process. For example, the theory of reading proposed by Just and Carpenter (1980) attributes processing time and capacity in reading comprehension to figuring out the relationships within sentences and among sentences and paragraphs.

A method for identifying text structure is a necessary procedure for examining the reading comprehension process. In order to examine what information a reader has processed from a text, the researcher needs to know just what information was presented in the text. Thus, the procedures for analyzing text structure and content have been put to use as scoring templates to access a reader's recall of text. For example, if a passage's structure is analyzed so that the information it contains is

divided into units of topic content and relations, then this analysis can be employed to assist in scoring just which of the content and relation units were remembered by a reader.

Moreover, researchers hypothesize that the representation of the text in memory is parallel to their analysis of the text structure. Comparisons of structures identified from the text and those identified from readers' recall protocols assist investigators in attempts to validate their models of the representation of text in memory. Models of memory representations based on prose analysis procedures are usually posited from certain types of learners (i.e., skilled readers with relatively low prior knowledge on the text topic) under certain types of task conditions (i.e., reading for optimal comprehension and recall of text information with adequate time and immediate recall). Investigators examine variations between the text structure and analyses of recall protocols when the types of learners and task conditions are varied systematically.

Another reason for specifying text structure deals with problem of generalizing research findings with a particular passage to other texts. Text structure is a significant dimension along which text selections can be evaluated as to their similarities and differences. Investigators of reading comprehension have made some progress in characterizing certain discourse types, such as simple stories (Mandler & Johnson, 1977; Rumelhart, 1977), scientific reports (Kintsch & van Dijk, 1978), and exposition (Meyer, 1977; Meyer & Freedle, in press). However, discourse types have been examined more by rhetoricians (D'Angelo, 1976) and linguists (Longacre, 1970). Recently, Brewer (1980) has identified three underlying structures of discourse: description, narration, and exposition and four purposes: to inform, to persuade, to entertain, and literary aesthetic;

exposition was classified only under the first two purposes. We are beginning to make progress in determining which aspects of text structure are important to consider in differentiating among text selections.

Reasons for Different Approaches for Identifying Prose Structure

Given the usefulness in reading research for specifying the structure of text, it might be expected that researchers would by now have converged on a simple, universally accepted method. There are at least three reasons for the lack of such a method. First, interest in specifying text structure has historically come from a variety of disciplines, including rhetorics, folklore, linguistics, education, psychology, and artificial intelligence (cf., Meyer & Rice, in press). These disciplines have had different approaches and goals for analyzing text structure. The multiplicity of disciplines involved serves to diversify the text structures proposed as well as enrich our understanding of text structure.

A second reason for the variety of text analysis systems currently used to study reading comprehension results from the purposes for which they were developed. For example, if the research goal is ascertain recall of the gist of passages, the analysis structure may be quite different than if the goal is memory storage of logical relationships.

The most difficult obstacles are those which are inherent in the complexity of text, the writing process, and the reading process (see Figure 1). Part of the problem arises from the complexity of the reading process (Meyer & Rice, in press). Since the text and reader interact in this process, it is hard to isolate entirely textual variables. The structure of the information read from a text may appear differently to readers with different prior knowledge and purposes. A reasonable escape from this problem is

to analyze text from the point of view of the author. However, there are some problems with this approach. If a poorly written exposition is selected which fails to explicitly or implicitly logically interrelate ideas (i.e., Flower's, 1979, writer-based lists, rather than reader-based conceptual hierarchies), the text analyst may want to identify the potential conceptual structure underlying the topic in order to better score recall of more astute readers. Even with well-written text, the underlying structure may be implicit rather than explicitly signaled. In these cases, it is necessary for the text analyst to make inferences about the organization in the text. Individual differences among analysts in making such inferences can produce variability in the analyses produced.

As depicted in Figure 1, a text is a result of the cognition (induction, comparison, etc.) of the author and his/her skill in putting this logic and message in written form. Brewer (1980) noted that the underlying mental processes involved in his three discourse types differed. For descriptive text, he explained that the underlying cognitive representation was visual-spatial. For narrative text, he stated that the central mental representation was a series of temporally occurring events, a time line (Litteral, 1972). Expository text was said to reflect the underlying mental processes involved logical and quasi-logical thinking.

As shown in Figure 1, the match between the logic and message intended by the author and that identified in the analysis of text structure varies with the author's skills, the prose analysis procedure, and the skill of the analyst using the procedure. In most prose learning experiments, the analysis of the text structure is then compared to what the reader recalled from the text. The similarity between the analysis of the text structure and what the reader writes about what s/he remembers from the text depends

on the prior knowledge, purpose, and skill level of the reader (Meyer, 1981). If the reader's purpose was to understand the topic from the author's perspective, then the correspondence between the analysis of the text structure and the recall protocol will increase with reader skill, exposure time, and recency from presentation.

Meyer's Approach to Prose Analysis

The paradigm diagrammed in Figure 1 depicts the approaches which I use to study reading comprehension from expository text. The content structure represents the underlying logic and message of the text from the perspective of the author. A skilled reader, with the prior knowledge assumed by the author, and a desire to understand the author's logic will form a representation of the text in memory parallel to that of the content structure. The comprehension process will follow a structure strategy (Meyer, Brandt, & Bluth, 1980) and involve an active effort to discover the superordinate structure of relationships and the information it binds (the gist) (for example, see Figure 2 for supertanker passage). The general theory of reading posited by Just and Carpenter (1980) is a compatible framework for this approach to prose learning.

As shown in Figure 1, the content structure can serve as a scoring template to examine the amount and type of information remembered by a reader. Also, the recall protocol of the subject can be analyzed with the same prose analysis procedures to detect differences in the organization and type of information recalled. In this way, content, relationships, and superordinate organizational structures which did not occur in the original text, can be identified and classified (see scoring system in Appendix). For example, Meyer, Brandt, and Bluth (1980) found that poorer comprehenders at the ninth-grade level organize their recall protocols with a list format,

a collection of non-related descriptions about a topic, while good comprehenders organize recall of expository text with its inherent logical relationships. That is, the text structure as a model of text information in memory is a better representation of text memory for good comprehenders than poor comprehenders.

The method I employ to get from the text to its underlying structure and from the protocol to its underlying structure is a procedure based on the work in linguistics of Grimes (1975) and Fillmore (1968). The correspondence is considered high between the content structure analysis and the logic and message in the mind of the author and the reader. The relationships which form the logic in the content structure appear psychologically valid. They have been discussed as ways or schemata for thinking about ideas at least since Aristotle (1960). The content-based relationships (verb type relationships) also appear to be schemata used in cognition (Rumelhart & Ortony, 1977). The levels in the content structure are dictated by the major logical relations; the hierarchy is hypothesized to relate to allocation of processing time and access to retrieval when reading in tasks for prose learning experiments and many similar school tasks (Meyer, Brandt, & Bluth, 1980).

Three primary levels of expository text are identified in this approach to prose analysis (Meyer, 1981; van Dijk, 1979). The first is the sentence or microproposition level, which is concerned with the way ideas are organized within sentences, and the way sentences cohere and are organized within a text. The second is the paragraph or macropropositional level, which pertains to the issues of logical organization and argumentation. The third is that of the top-level structure or overall organization of the text as a whole. Figure 2 depicts these three levels from a text on supertankers.

Micropropositions. The subordinate micropropositions are indicated by ⋀ in Figure 2, but are diagrammed in the content structure which can be found with the text in the Appendix. The structure of simple sentences is diagrammed with case grammar (after Fillmore, 1968, and Grimes, 1975). Most text analysis systems use case grammar at this level of analysis.

A salient property of texts is they cohere or "hang together." A text coheres when the interpretation of one element depends upon or presupposes another (Halliday & Hasan, 1976). Halliday and Hasan (1976) have identified mechanisms (reference, substitution, ellipsis, conjunction, and lexical cohesion) by which authors tie phrases and sentences together at this microproposition level. Issues of coherence and connectivity are not explicitly treated by the system; instead, they are used as cues to guide the analysis.

Macropropositions. The term macroproposition, equivalent to van Dijk's (1977) macrostructure, refers to the level of prose analysis at which gist of portions of the text is central. Whereas at the microproposition level, the relationships within and between individual sentences was at issue, at the macroproposition level the issue is with the relationships among ideas represented in complexes of propositions or paragraphs. The relationships at this level tend to be logical or rhetorical. A number of classifications of the types of logical relations which operate in text have been proposed (Beaugrande, 1980; Frederiksen, 1975; Grimes, 1975; Halliday & Hasan, 1976; Meyer, 1975).

Five basic groups of relationships can be identified (collapsing the relationships of Grimes, 1975; Meyer, 1975, 1981). They are:

1. collection — relation which shows how ideas or events are related together into a group on the bases of some commonality;
2. causal — relation which shows a causal relationship between ideas where one idea is the antecedent or cause and the other is the consequent or effect;
3. response — or problem and solution (also remark and reply, question and answer formats) is similar to the causal in that the problem is an antecedent for the solution. However, in addition, there must be some overlap in topic content between the problem and solution; that is, at least part of the solution must match an aspect of the problem;
4. comparison — points out differences and similarities between two or more topics;
5. description — gives more information about a topic by presenting attributes, specifics, manners, or settings.

In the texts which my students and I have examined, the gist or macropropositions have been explicitly stated. For example, in the supertanker passage (see Figure 2 and the Appendix), the gist is "oil spills from supertankers damage the environment; this problem results from lack of power and steering equipment in emergencies. The solution involves better training of officers, building tankers with extra power and steering

equipment, and installing ground control stations." This gist statement was written by following the superordinate structure in the top third of the content structure. In passages without explicit gist statements, macropropositions can be generated using van Dijk's (1977) macro-rules. For example, the supertanker passage could have been written without the more general statement that oil spills damage the environment; instead, the four examples of oil spills (lowest three levels in Figure 2) could have been presented alone. Then, the text analyst and reader would need to generate the macroproposition, oil spills from supertanker cause damage to the environment.

Top-level structure. The top-level structure of the text corresponds to its overall organizing principle. For example, the rhetorical relationships described above can serve to organize the text as a whole. The response: problem/solution is the top-level structure which subsumes all the content and relationships in the supertanker passage (see Figure 2).

The five rhetorical relationships of collection, causation, response, comparison, and description represent ways of thinking about topics (abstract schemata). The first three types of relations appear to line up on a continuum of constraints as shown in Figure 3. The arguments or information to be related by the collection relation have to meet fewer constraints than do those for the response relation. The comparison relation, like the response relation, has interlinking of the subtrees of its arguments: but time and causality are not factors. Different types of argumentative text may differ on the extent with which their subtrees overlap. For description the arguments are grouped on a topic but in a hierarchical manner; one argument is superordinate and the other modifies

this superordinate argument. Examples of these relationships can be seen in Figure 2 and the Appendix. Since some of these rhetorical relations require more links among their arguments than others, a network model of memory (Anderson, 1976) might predict different memory performance with text processed and retrieved with these different structures. There is some evidence (Meyer, 1977, in press; Meyer & Freedle, in press) for inferior memory of text with top-level structures in the form of a collection of descriptions, where the descriptions are grouped on the basis of dealing with the same topic but are not interrelated (lowest level on the continuum in Figure 3).

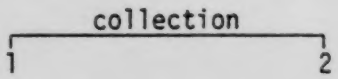
My colleagues and I have examined exposition with this type of top-level structure, but have primarily examined text with response: problem/solution, comparative, and descriptive (i.e., assertion and its evidence, statement and examples) top-level structures. The five rhetorical relations listed above can be combined in a wide variety of ways to provide a number of possibilities for the superordinate relational structures of exposition. However, the problem/solution expository texts which we have examined appear to require at least the components shown in Figure 4. Most of the work pertaining to the more specific top-level structures has been done with story structures (Mandler & Johnson, 1977; Rumelhart, 1975; Stein, 1979).

Building the content structure. In Meyer (1975), I presented the three distinct sets of relationships identified by Halliday (1968) and Grimes (1975) as content, cohesion, and staging. I have come to realize that the content structure resulting from the prose analysis procedure embodies all three sets of relations, not just content.

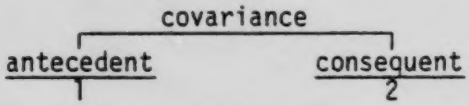
The content structure is best formed by following a top-down procedure. The passage is first examined for its top-level structure. This skill has been readily taught children and disabled populations (Bartlett, 1978; Bartlett, Turner, & Mathams, Note 1; Jessen, Note 2). Using the five rhetorical relationships described above (rather than the more minute classification in Meyer, 1975), one relation can be selected as the top-level structure of a text. The top-level structure will be the relationship which can subsume the greatest amount of text (see response in the supertanker passage). If we had only the first paragraph of the supertanker passage, then the top-level structure would be description; a description with subordinate, embedded causal relationships.

The hierarchical levels of the content structure are formed by the analysis format of the rhetorical relations and the analysis format used for the case grammar analysis. The formats for the rhetorical relations are as follows (numbers 1 and 2 represent arguments which are interrelated):

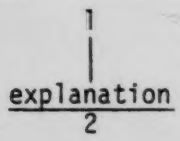
collection - equal level in the content structure



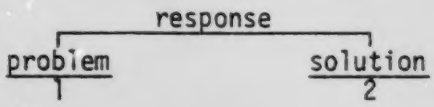
causation - (a) equal level in the content structure



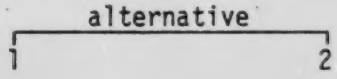
(b) unequal level for explanations (explanations are antecedents, but subordinate in staging to event or idea explained)



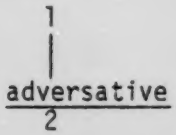
response - equal level in the content structure



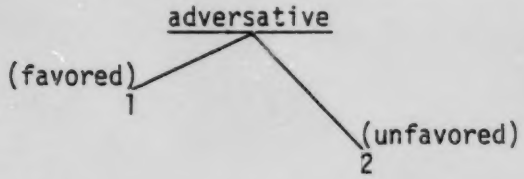
comparison - (a) alternative, equal level; equally weighted views or options



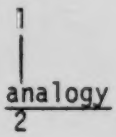
(b) adversative, unequal level; unequally weighted; one is favored



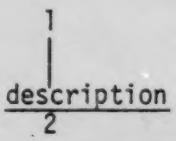
For a more aesthetically pleasing top-level structure, it can be put in the following format:



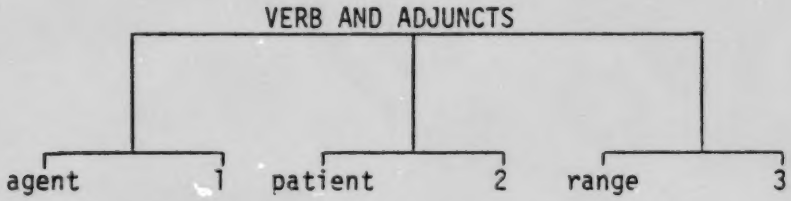
(c) analogy, unequal level; analogy is subordinate



description - unequal level; descriptive argument is subordinate (includes manner, attribution, specific, evidence, equivalent, settings, identifications in Meyer, 1975)



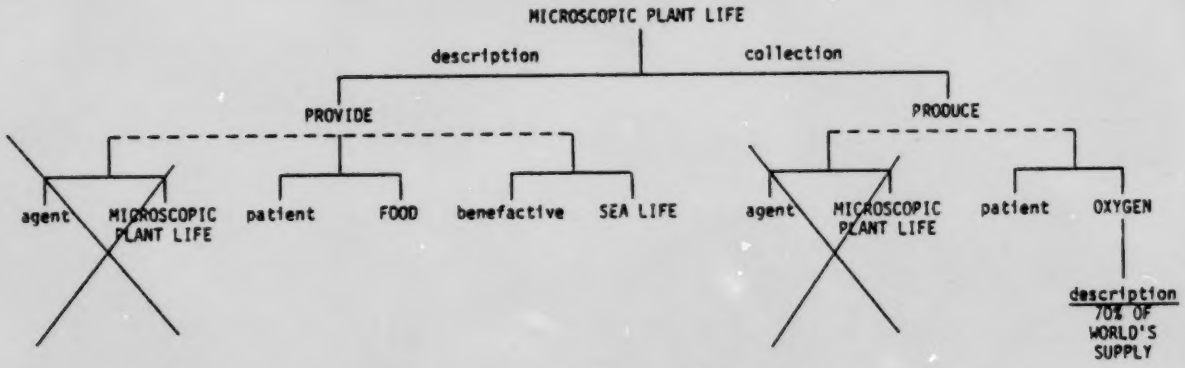
In the case of selecting adversative rather than alternative staging or signaling (Meyer, 1975), such as "the best option is," assist the analyst in deciding the format of the content structure. However, the signaling words themselves do not appear in the content structure, but their input is represented in its organization. The content structure is formed by unpeeling layers of rhetorical relationships in a top-down fashion. For example, once the top-level structure is identified, then the next most inclusive relations are identified until the case grammar level of analysis is reached. The format for the case grammar analysis is as follows:



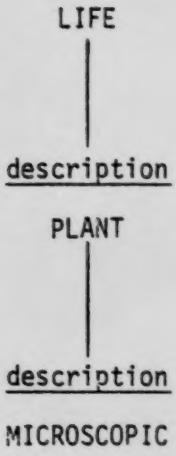
The verb (lexical predicate) is one level above the equally weighted role or case-related arguments.

When relating a superordinate idea to a description comprised of one or more lexical propositions which can be analyzed with case grammar, a format rule is used to avoid excessive repetition in the content structure. The idea being described is placed at the higher level in the content structure and it and its case relation are deleted in the subordinate proposition. For example, see idea units 9-26 of the content structure analysis in the Appendix. In the supertanker passage, there is the sentence "Oil spills also kill microscopic plant life which provide food for sea life and produce 70 percent of the world's oxygen supply." As seen in Figure 2 "Kill microscopic plant life" is one of the consequences of

oils spills. The remainder of that sentence describes microscopic plant life (see idea units 159 to 171 in the Appendix). As can be seen below, the agent and microscopic plant life are deleted in the subordinate propositions by this format rule.



This example also brings up the problem of how far to analyze arguments. It depends on your purpose. For teachers using the approach to teach top-level structure, they may want to stop with the top-level structure. In studying the logic of exposition in reading and writing instruction, an analysis similar to that in Figure 2 may be useful. For prose learning studies, it depends on the research questions and your resources; the more minute the analysis, the longer the scoring time. For example, microscopic plant life could be analysed as



If you are interested in these distinctions in recall, then you should analyze the text at this level. If you do not analyze it completely, then you have to make scoring rules to identify crucial components (see Appendix for sample scoring rules). Even if you do analyze to the level of each content word in the text, you still may not be at the endpoint of the referent indicated and activated in the mind of the author or reader. Thus, you will always need to make generous rules for scoring substantive recall.

This system of prose analysis is applicable to all types of expository prose and has also been applied to story materials (here a time line for collection: sequence is required, Meyer, Haring, Brandt, & Walker, 1980). The minimal unit of analysis is the idea unit, which includes both actual content named in the text and relational terms inferred from the text. The analysis produces a single, hierarchically organized representation of a passage's structure. It is a propositional structure with the relationships (predicates) at the microproposition level held primarily by verbs from the text, while at the macroproposition level, they are held

by the rhetorical relations. The arguments are individual content units from the text or content units which are parts of other propositions.

Meyer (1975; Meyer, Brandt, & Bluth, 1980) has manipulated signaling independent of the content structure. The way the content structure is organized shows how the content has been staged in importance and how it has been logically organized by an author. However, explicit words of signaling (Meyer, 1975) can be added or deleted in a text. For example, the signaling words listed in the right column in the content structure of the supertanker passage (see Appendix) could be deleted from the text. Then, the readers would have to infer these relations; however, the content structure of expository text would remain the same for the signaled and non-signaled text.

Using text organization in the reading process. The structure strategy is the dominant reading strategy hypothesized for skilled comprehenders in a prose learning task. These readers search out and follow the text's superordinate relational structure (i.e., see Figure 2) and focus on the text's message and how it relates to supporting major details. We have found that skilled readers approach text with knowledge about how texts are conventionally organized and a strategy to seek and use the top-level structure in a particular text as an organizational framework to facilitate encoding and retrieval (i.e., Bartlett, 1978; Meyer, 1981; Meyer, in press; Meyer, Brandt, & Bluth, 1980; Meyer & Freedle, in press). Organization in text as well as other verbal tasks has been shown to be a crucial variable in learning and memory (cf., Kintsch, 1977, Chapter 5).

Processing activities hypothesized for the structure strategy are similar to explanations given for the levels effect by Anderson (1976) and Kintsch and van Dijk (1978), only primary emphasis is placed on a search for interrelationships among chunks of complex propositions in text. Anderson (1976) explained that high level propositions, central propositions in the network of this computer simulation model, are more frequently called up to help interpret the more peripheral low-level propositions. This constitutes extra rehearsal of high level propositions and results in increasing the probability of their recall. Similarly, Kintsch and van Dijk (1978) explained that high level propositions are processed differently than low level propositions. High level propositions are hypothesized to be more frequently retrieved from long-term memory and kept in the short-term memory buffer as old propositions to be related to incoming new propositions in the reading process. In the Kintsch and van Dijk (1978) model, high level propositions are identified by repetition of arguments or concepts. The model does not specify how the extreme superordinate proposition is identified; this proposition is crucial since repetition of its arguments dictates moving down in the hierarchy and building the text structure. At present the superordinate proposition is selected on an intuitive basis with the expectation that further work with their macroprocesses component will help to explicate this choice.

The superordinate rhetorical relationships in text along with readers' prior knowledge of them appear to play a crucial role in comprehension and must be integrated more fully into the macroprocesses component of the Kintsch and van Dijk model. High level propositions need not be identified

solely on argument repetition, but they can be identified as the arguments of the major rhetorical relationship or top-level text structure. The extreme superordinate proposition is then identified as the content bound by the top-level structure. For example, in the first paragraphs of the passage reproduced in the Appendix, the extreme superordinate proposition is oil spills. It is explicitly signaled as the problem in the first sentence of this passage, which is written with a problem/solution top-level structure commonly found in scientific articles. Thus, a focus on relationships and top-level structures can be used to specify the superordinate proposition in a structural analysis.

Processing activities for the structure strategy focus on a search for major text-based relationships among propositions. That is, there is a search for relationships which can subsume all or large chunks of this information and tie it into a summarized comprehensible whole. Readers employing the structure strategy are hypothesized to approach text looking for patterns that will tie all the propositions together and the author's primary thesis which will provide the content to be bound by these patterns or schemata. Then, they search for relationships among this primary thesis and supporting details. For example, when reading the supertanker text they recognize in the first sentence that the propositions may fit their problem schema. Each new proposition is related back to the problem, making the problem of oil spills from supertankers continually selected for retention in the short-term memory buffer for interpreting the new propositions. Previous knowledge about problems keeps the readers searching for causal relationships among descriptive information about the problem, such as why it is a problem and what caused

it. Also, prior experience with problems leads readers to anticipate and search for solutions, solutions which must satisfy most of the previously stated causes of the problem. Thus, the problem and its causes are retrieved continually from long-term storage to the short-term memory buffer for relating to the subsequent propositions in the passage. This additional processing of these superordinate propositions and their interrelationships increases the depth with which they are processed (Craik & Lockhart, 1972) and the subsequent ease with which they can be retrieved.

The top-level structure and major interrelationships are also employed to guide retrieval and production of the recall protocol; it is hypothesized to a top-down retrieval search guided by the structure of relationships. Readers are assumed to construct memory representations of text propositions which are similar in terms of both hierarchical relationships and content to the content structure depicted in Figure 2 and in the Appendix. When recalling the text, they begin their retrieval search with the top-level structure and systematically work from the superordinate relationships and content downward.

Readers process text line by line in a linear fashion; they do not wait until after they have read the entire text to find the top-level structure and other superordinate relations which subsume large chunks of text. Words in the text, such as "problem," "need to prevent," "in contrast," "others disagree," "others believe," "as a result," other signaling words and content words, help readers to make educated guesses about which relational pattern or schemata to assign to the text. If later sentences are not compatible with an initial assignment, then

reassignment can be made and the reader probably will reread the text segments involved.

Since explicit signaling of top-level structure and superordinate relations should make this assignment easier, we have conducted a number of studies on the effects of signaling these relationships (cf., Meyer, in press; Meyer, Brandt, & Bluth, 1980). The presence or absence of signaling in well-organized text appears to have minimal effects on good comprehenders who employ the structure strategy. For most passages studied, it does not influence the way they organize their recall protocols, the amount of information recalled, nor the type of information recalled (cf., Meyer, 1975, in press; Meyer, Brandt, & Bluth, 1980). Although it does not affect reading speed, it does appear to affect cognitive capacity as measured by reaction time to a secondary task (reactions to random clicks while reading text with and without signaling, Britton, Glynn, Meyer, & Penland, in press). Ninth graders with high reading comprehension test scores (Meyer, Brandt, & Bluth, 1980) and most students attending undergraduate and graduate colleges (cf., Meyer, 1981, in press) follow the structure strategy regardless of the presence of signaling. For these skilled readers, the structure strategy may be well-learned and automatic; words like "need to prevent" are sufficient to automatically assign a problem/solution schema. However, for poorer comprehenders (Meyer, Brandt, & Bluth, 1980) explicit signaling, such as "the problem is" were necessary before these readers could apply the structure strategy. The structure strategy may be a conscious mnemonic strategy for these students as it is for those students who are participating in training programs to teach top-level

structure (Bartlett, 1978; Bartlett, Turner, & Mathams, Note 1; Jessen, Note 2).

The exact processes involved in assigning schemata (top-level structures, superordinate relations, and more concrete content schemata) to text have not been explicated. The final section of this chapter deals with the manipulations of signaling and specificity of details which led to the assignment of different top-level structures for a text on railroads. These manipulations in this particular text caused readers to vary in assigning either a comparison or a collection top-level structure for comprehension and recall of the text.

General Comparison of Meyer's Approach to Others

The Kintsch (1974) system also produces a hierarchical representation, but follows the surface structure more closely. The minimal unit of analysis is the proposition, which is defined as a relationship and its arguments (e.g., Jennifer loves Zona is [Loves, Jennifer, Zona]). Analysis of a passage with this system produces a text base (a list of propositions), and a hierarchical ordering of these propositions. Argument repetition is the basis for forming the hierarchy. The system is applicable to expository prose in which a hierarchy of logical relations is not particularly important, though it has been applied to all varieties of prose. It is particularly appropriate where the concern is with content items rather than their interrelationships. Since the hierarchy is built on the basis of repetition of content, rather than identification of logical relationships as in the Meyer (1975) system, it is a simpler system

to learn and to apply. However, Bieger and Dunn (Note 3) have found Meyer's model of text structure more sensitive to developmental differences in recall than Kintsch's model; the significant difference being that Meyer's approach explicitly represents and scores both inferred and explicit relationships in text, while Kintsch's approach does not.

The text base and its hierarchical structure are the facts of the text which correspond to the microproposition level. They consist of propositions arranged in a hierarchy through argument repetition (repetition of content). In making the hierarchy, other forms of cohesion are not considered. Selection of the most superordinate proposition is done on the basis of intuition. Different hierarchies can be formed if different propositions are selected for this superordinate position.

Many of the expository texts used by Kintsch (1974) do not have summary or preview statements (signaling, Meyer, 1975), while Meyer's texts (frequently Scientific American articles) do. Thus, the macropropositions of Meyer's system are the gist or summary. The top third of the propositions in Kintsch's text base are the most important facts of the text, as indicated by the repetition of their concepts in the rest of the text. However, they do not provide a summary of the passage's gist.

Thus, Kintsch and van Dijk's model (1978) of text comprehension has the reader operating on the text to construct the macrostructure, equivalent to Meyer's macropropositions. The macrostructure results from the operation of the macro-operators, which are a set of abstraction, or summarization, rules (van Dijk, 1977).

For Kintsch and van Dijk (1978), the top-level structure is an independent organization overlaying the propositional analysis, rather than

an emergent structure as in the Meyer system. This is because only highly conventionalized top-level structures have been studied, e.g., stories or scientific articles.

The Kintsch system was developed originally to aid in determining what information in a passage was available to the learner so that recall could be more easily scored (the usual comparison seen in Figure 1). In more recent years, it appears as a key element in a model of text comprehension which is being developed by Kintsch, van Dijk and colleagues (Kintsch & van Dijk, 1978; Kintsch & Vipond, 1979; Miller & Kintsch, 1980). This model ingeniously and mechanically relates the levels and paths in the text hierarchy to the capacity limitations of short-term memory.

Frederiksen's (1975, 1977) system also applies to various types of expository prose. The minimal units of analysis are the concept, which may be a single word or word group, depending on the specificity desired, and the relation. Analysis does not produce a hierarchical structure, but rather "structure graphs" which have more of the quality of networks. The Frederiksen system is particularly appropriate in situations where investigators require a method for scoring inferences made by readers.

At the microproposition level, Frederiksen describes an elaborate set of relations which hold among concepts. The system at this level is very similar to the micropropositional level of Meyer's system; however, Frederiksen's system makes more distinctions within types of relationships.

The analysis system does not provide natural segmentation into hierarchical levels. However, some logical relations defined at the micropropositional level could be adapted for use at a macroproposition level. There are no provisions for the top-level structure.

The Frederiksen system was developed to handle issues in learning and recalling of logical relations and makes finer distinctions among relationships than the other two approaches. The system was also formulated to study inferences (Frederiksen, 1975). Also, Frederiksen (1975) has defined types of information in recall protocols more descriptively: veridical recall, overgeneralizations, pseudodiscriminations, text implied inferences, and elaborations (inferences from prior knowledge). The first four are scored as present in a protocol in Meyer's system but distinctions among them are not made.

The Frederiksen system was designed to exemplify a model of text knowledge in the mind apart from the organization of the original text with its emphasis of some ideas and subordination of others. Thus, in Figure 1, Frederiksen attempted to move right from the text to the reader's memory. He did not look systematically at prior knowledge frames or schemata and their contribution to the text comprehension in the reader's mind as have later investigators (Beaugrande, 1980; van Dijk, 1977). For example, van Dijk (1977) suggested identifying content related frames or schemata to understand the reader's processing of text. For example, a passage about a war will derive some of its organization from a war "frame," in which is represented component states and the necessary or probable conditions and consequences of wars in general. The asset to applying this sort of content analysis in the classroom is that it can help identify the background information which students will need to understand a given text. The disadvantage is that it is not possible to specify in advance a bounded set of relations to be used in the analysis, as is possible for both Meyer and Frederiksen.

A recent approach by Beaugrande (1980) produces elaborate networks of content with relations, both syntactic and conceptual, clearly marked. This analysis of the text is called the text-world model. An important attribute of Beaugrande's approach is that it applies the same type of relationships to the text as to prior knowledge of readers and attempts to mesh the two. For example, Beaugrande investigates the prior knowledge schemata which subjects bring to the topic of rockets, such as the flight schema. He also produces a network of facts readers would be likely to know before encountering the text (i.e., rockets take-off), called the world-knowledge correlate. A comparison is made between the text-world model and a similar analysis of reader's recall protocol. In addition, the analyses of potential schemata and the world-knowledge correlate are compared with the analysis of the reader's recall protocol (note variation in these comparisons with those seen in Figure 1). The system is complex and does not appear to result in dimensions which could be readily used for classifying text.

In summary, the prose analysis systems of Meyer, Kintsch, and Frederiksen differ in their strengths and suitability for different types of passages and research questions (see Table 1). Meyer and Frederiksen's systems are better suited to examining logical relationships and comprehension of these relationships explicitly or implicitly stated in text. The logical relationships in Meyer's model closely follow those suggested by the text, while the superordinate level in Frederiksen's are drawn not from the text but from semantic knowledge (see Meyer, 1975). Thus, Meyer's system would probably be more effective for studying writing; it closely parallels work in rhetorics. In Meyer and Frederiksen's system protocols can be scored for recall of relationships independent from correct recall of content; this is not the case in Kintsch's system where propositions are the units for scoring rather than

their component relation and arguments. Both Meyer and Kintsch's system provide clearly specified hierarchies, while this is not the case for Frederiksen's approach. Kintsch's system is probably the easiest to apply. However, Meyer's approach gives a more articulated structure (Cofer, Scott, & Watkins, Note 4).

Detailed Comparison of Kintsch and Meyer Approach

A more detailed examination of the approaches of Kintsch (1974) and Meyer (1975) will be given here. Both approaches recognize the need for integration with knowledge frames of the reader, etc., but this is a comparison of the systems as they currently stand. The text used for comparison of the analysis and scoring procedures is the one selected by Miller and Kintsch (1980) entitled the "Saint." The text is as follows:

"Saint" text (see Miller & Kintsch, 1980)

> In the request to canonize the "frontier priest," John Newmann, bishop of Philadelphia in the 19th century, two miracles were attributed to him in this century. In 1923, Eva Benassi, dying from peritonitis, dramatically recovered after her nurse prayed to the bishop. In 1949, Kent Lenahan, hospitalized with two skull fractures, smashed bones and a pierced lung after a traffic accident, rose from his deathbed and resumed a normal life after his mother had prayed ardently to Newmann.

The text is much shorter than passages usually analyzed with the Meyer approach. The context of the text would be important to better articulate a top-level structure. However, in isolation it would be classified as a descriptive text; two examples or instances of an idea (miracles) are given in a particular setting (the request to canonize Newmann).

Analysis of the Saint text. Figure 5 lists the text base for the "Saint" given by Miller and Kintsch (1980). There are 29 propositions; each can be scored. Figure 6 presents the content structure of the Saint text from the Meyer approach; there are 90 idea units which can be scored. The Meyer analysis allows each content unit and each relationship to be scored separately. In the Kintsch analysis, only two lexical relations, REQUEST (P 1) and CANONIZE (P 2), and two causal rhetorical relations, AFTER (P 14) and AFTER (P 27) can be scored regardless of whether or not readers correctly remembered their arguments.

Figure 7 depicts the coherence graphs for the Saint text as indicated in Miller and Kintsch (1980). They indicated that at the end of processing the text, there were two subgraphs in memory instead of the three indicated. Since sentence 2 connects with sentence 1 by overlap of the word BISHOP, these two graphs may be interrelated but it was not clear to me how to interrelate them. For sentence 1 REQUEST was selected as the subordinate proposition on the basis of intuition. P 2, P 8, P 9 are placed at level 2 because they share arguments with P 1.

Figure 8 presents the superordinate structure of relations for the Saint text as identified by the Meyer (1975) approach. WERE ATTRIBUTED was selected for the superordinate level for the following reasons. The three sentences were searched for a rhetorical relation which would subsume all the content; none was found. However, a description relation interrelates MIRACLES to the two examples of miracles. The lexical proposition with the lexical relation (predicate) or verb WERE ATTRIBUTED interrelates the arguments in the first sentence, and one of its arguments MIRACLE can be related by the description relation to the propositions in the remaining two sentences. Thus, WERE ATTRIBUTED binds the information contained in the

first sentence and description, collection binds the first sentence through MIRACLES to the examples of miracles in the next two sentences. WERE ATTRIBUTED was selected for the superordinate level rather than REQUEST because WERE ATTRIBUTED is the verb or lexical predicate binding the ideas in the first sentence, not REQUEST. REQUEST is a lexical predicate, but is not the binding relationship or verb in the first sentence. As can be seen under the first column in Figure 5 which gives the recall data from the Miller and Kintsch (1980) experiment, ATTRIBUTED (104) and REQUEST (101) are both well recalled.

For the first sentence of the Saint text, the relative placement of ideas in the hierarchies of the two analysis systems are about the same. The REQUEST and ATTRIBUTED are near the top and PHILADELPHIA and 19th CENTURY are at the bottom. However, miracles is higher in the Meyer analysis (level 2 out of 5) than in the Kintsch analysis (level 3 out of 4); the recall of miracles is very high (110).

For the second sentence agreement is still relatively high. However, the second sentence is integrated into the Meyer content structure by the description relation, and the sentence may be integrated into the subgraph for sentence one by the repetition of the argument BISHOP in the Kintsch analysis. The major difference in the two analyses of sentence two is the treatment and format of the causal type relation in EVA RECOVERED AFTER HER NURSE PRAYED. In the Miller and Kintsch analysis, the consequent RECOVERED is two levels higher than the antecedent PRAYED, while they are at equal levels in the Meyer analysis.

Less agreement for the two approaches to text analysis is found for the final sentence. For the Meyer approach, the propositions in sentence three are integrated into the one content structure as another example of MIRACLE.

Connected memory structures for both writer and reader would be expected similar to those in Figures 6 and 8. However, sentence 3 forms a separate subgraph in the Miller and Kintsch approach. For Miller and Kintsch, the superordinate level proposition (P 18 FRACTURES SKULL KENT LENAHAN) is selected by intuition. Then the connecting of the other propositions to the superordinate is done on the basis of argument overlap. More specifically, "all propositions that share arguments with the superordinate or are embedded in the superordinate are placed at Level 2 of the graph and connected by the superordinate. The propositions from this input chunk as yet unassigned to the graph are then compared to the propositions now at Level 2, and any that share arguments or are referenced by the Level 2 propositions are so connected and placed at Level 3 (Miller & Kintsch, 1980)." P 17, P 20, P 1, P 24, and P 25 are placed at level two because they all share the argument KENT LENAHAN: P 19 (TWO P 18) is also at level two because P 18, the superordinate, is one of its arguments. Once intuition is applied to select the superordinate, the construction of the subgraph is built in this mechanical and objective manner. The logic of the exposition does not guide the construction of this text structure; instead the structure is built of intuition for the main idea or superordinate and then repetition of arguments. However, look at the high recall of the logic in this text from the Miller and Kintsch study (see Figure 5 rhetorical relations: P 14, P 22, P 27 and lexical relations: P 1, P 2, P 8). The rhetorical relations (AFTER) are not particularly high in the Kintsch subgraphs.

In contrast, the Meyer approach builds the structure from the logical relationships in the text. As seen in Figure 8, sentence 3 is connected to the rest of the text by <u>description</u>, <u>collection</u>. Then the sentence is

examined for the superordinate relationship which can subsume all of its content. This relationship is the causal relation which links what happened to KENT LENAHAN with what his mother did--PRAYED. Thus, as shown in Figure 8, the first step in the analysis of sentence 3 is the division of the ideas into antecedent and consequent propositions. The antecedent is simply analyzed with case grammar and a descriptive (manner) relation as shown in idea units 81-90 in the content structure (see Figure 6). The consequence of the prayer was a collection of actions; KENT ROSE and RESUMED (see Figure 8). The description of KENT LENAHAN when he ROSE FROM HIS DEATHBED contains another causal relation. KENT had been HOSPITALIZED with a collection of injuries (units 57-67 in the content structure) AFTER A TRAFFIC ACCIDENT. As shown in Figure 8, the ACCIDENT is the antecedent and the consequent is HOSPITALIZED with the collection of injuries.

The two analysis approaches are quite different for sentence three due to the fact that intuition led Miller and Kintsch to select FRACTURES SKULL KENT-LENAHAN as the superordinate proposition. Following the structure of rhetorical and lexical (verbs) relations (this procedure requires educated inferences) led Meyer to place this same information (idea units 55, 58, and 61 in Figure 6) at the lowest levels of the hierarchy, levels 6, 7, and 8. According to Miller and Kintsch's recall data, recall of this information was relatively high (93), but not as high as predicted by their text structure analysis and subsequent model (102). This content FRACTURED SKULL, SMASHED BONES, PIERCED LUNG is very vivid and image evoking; this does increase recall of details.

In evaluating the two analysis systems several strengths and limitations for each approach can be made. The Kintsch approach is simplier and probably

would require less analysis time. Once the superordinate proposition is selected subgraphs can be objectively and simply formed by finding repetition of concepts. Problems for this approach involve selecting the superordinate proposition and linking the text's content into one coherent graph with aspects of coherence other than argument repetition. Miller and Kintsch (1980) recognize the problem inherent in their selection of the main idea based on intuition. They hope to solve this problem by yet unspecified macro-components for their model. Reading educators have been interested in Meyer's approach to prose analysis because it can specify how to find the main idea, the content bound by the top-level structure or superordinate relationships (Meyer, in press). Attention to the logical relationships in the text may assist in the formation of the needed macro-components of the Kintsch and van Dijk (1979) model.

In addition, the Kintsch approach is not well suited to the study of rhetorical or logical coherence in exposition. Text relationships do not give form to the text structure and are not scored separately.

The Meyer approach requires considerable training in identifying these rhetorical relationships in text. Typical signals or explicit cues for these relations can be learned; when the relations are implicit these cues can be inserted to assist in the inference process. I have taught a number of students to analyze prose; our agreement is above 90%. It is higher if we decide before beginning the procedure to analyze the text to the level of its most specific text referents, as done for the Saint Text. It takes practice to master the technique and each analysis is quite time consuming. It takes about a day of work to analyze a short passage. Differences in content structures made by different text analysts can

occur when the text is vague or confusing. Judgments are involved just as they are with scoring substantive recall or analyzing a sentence with case grammar; training and practice eliminate most problems.

Scoring the Saint text. In this section a number of recall protocols written by different types of subjects under different conditions will be examined using the scoring systems of Kintsch and Meyer. The first recall protocol, I 13, was written by a graduate student immediately after listening to the Saint text.

Recall Protocol of Subject I 13

> In a request to canonize John Newman, the frontier priest, two miracles were attributed to him in the 19th century. In 1923, Eva Benassi was dying from peritonitis, but recovered after her nurse prayed to Newman (for her recovery.) In 1949 Kent Lanahan was hospitalized after a car accident; he had a pierced lung and multiple fractures. He rose from his deathbed and resumed a normal life after his mother prayed to Newman (for him.) Newman was the bishop of Philadelphia.

The scoring of this protocol for the Kintsch and Meyer structures can be seen in the columns labeled I 13 in Figures 5 and 6. A 1 in the space across from a scorable unit means that the unit was recalled, while 0 means it was not recalled. The recall protocol for subject I 13 shows extremely high recall of the text content with few prior knowledge intrusions. The circles on the protocol indicate the addition of implied patients in the lexical propositions with the lexical relation PRAYED. This could be noted in either system but not scored with the structures. The underlined segments are the only points where differences in scoring

between the two systems occur. The reader confused 19th CENTURY with THIS CENTURY; this confusion cannot be credited with any points in the Kintsch system; P 9 cannot be scored because THIS CENTURY was not recalled; P 6 cannot be scored because 19th CENTURY was not linked to PHILADELPHIA. However, in the Meyer approach content and relations are scored separately so some credit would be given. Accurate recall would have resulted in 4 points (units 16, 17, 18, 19); this confusion in subject I 13's recall receives 2 points (units 18 and 17) and the confusion is noted (see scoring rules in the Appendix). Similar differences between the two systems can be noted for MULTIPLE FRACTURES by comparing Figures 5 and 6.

The next protocol, I 7, is from a similar type of student under the same task conditions.

Recall Protocol of S I 7

> In the request to canonize the frontier priest, John Neuman, bishop of Philadelphia in the 19th century, two miracles were attributed to him. In 1923, Eva Benessi, who had peritonitis, was cured when her nurse prayed to the priest. In 1949 Kent Lanahan, who was in an accident and suffered 2 skull fractures and smashed bones rose from his deathbed and resumed a normal life after his mother prayed ardently to Neuman.

Again recall is high and accurate; the differences between the two systems are identified with underlining in the protocol. Credit cannot be given in the Kintsch system for WHO (KENT LENAHAN) WAS IN AN ACCIDENT because for P 22 HOSPITALIZED (P 17) is missing and for P 23 TRAFFIC is missing. However, some credit is given for recall of this information on the Meyer structure (content structure unit 69--also 52, 69 as it relates

to the rest of the sentence). For WHO (EVA BENASSI) HAD PERITONITIS I generously scored P 11 (DYING EVA-BENASSI PERITONITIS); in the Meyer system fewer points can be given to discriminate among people who know EVA HAD PERITONITIS and those who know EVA WAS DYING FROM PERITONITIS (see scoring of I 7 content structure units 29, 30, 33).

Total recall scores for the two protocols are 22 (76%) for I 13 and 23 (79%) for I 7 with the Kintsch method and 78 (87%) for I 13 and 77 (86%) for the Meyer method. The total recall scores are extremely high. For scoring recalls of this type from graduate students with high recall in an immediate recall task, Kintsch's approach is faster and effective for most purposes.

The next recall protocol, D 7, also was written by subject 7. However, it was written prior to protocol I 7 and listening to the passage. The subject was exposed to the passage as part of instruction in a class; she did not know that she would ever need to recall it.

Recall Protocol D 7

In the effort to canonize Neumann, the frontier, bishop of Philadelphia; somebody was in the hospital and rose from his bed

For this protocol, the differences in scoring systems only come for the last sentence where recall is less accurate. Since KENT LENAHAN was not recalled P 17 and P 24 cannot be scored in Figure 5, while the correct content and relations can be scored in Figure 6 (units 53, 54, 46, 49).

The recall protocol I 5 was written by a graduate student in the same experimental group as the other students immediately after listening to the passage.

Recall Protocol I 5

In an effort to canonize Neuman, Eva Benassi prayed to the saint to help him recover skull fractures, lung

In this protocol recall is low and inaccurate. Only two points (7%) of the Kintsch structure can be credited (P 1 and P 2); due to partial recall of other propositions in the Kintsch list, the underlined ideas in the protocol cannot be credited. In the Meyer analysis, the correct content and relations can be scored in isolation and credited. The recall score from the Meyer approach is 16 (18%). The following is this same subject's recall in the delayed, unintentional condition.

Recall Protocol D 5

In order to canonize Neuman--Eva B.

For this protocol the Kintsch approach would assign one point (3%), while the Meyer approach would assign four points (4%). For subject 5, greater differentiation between the immediate and delayed recall performance can be made with the Meyer approach than the Kintsch system (i.e., Kintsch: 2 immediate vs. 1 delay; Meyer: 16 immediate vs. 4 delay).

The next protocol D 41 was given by a graduate student in the same experimental situation for the unintentional, delayed condition.

Recall Protocol D 41

Father somebody prayed for a young boy and he was healed. The people from the local community (in U.S.A. = Midwest) also noticed that this had happened for others he prayed for. Therefore, a bishop wrote a resolution to nominate him for Sainthood to the Vatican. The Pope then authorized his sainthood.

Four points (14%) for this protocol were given in the Kintsch structure; those four points correspond to the only four relations in isolation (REQUEST, CANONIZE, AFTER, AFTER). Nineteen points (21%) were given in the Meyer structure. Neither system can do more than circle and record the prior knowledge intrusions (see scoring system in Appendix). This subject has brought in a prior knowledge frame or schema about procedures to acquire saint status in the Roman Catholic Church. An approach like Beaugrande's (1980) would be more appropriate in this situation. The protocol was written by a bright adult attempting to give coherence to fragments of knowledge about the Saint text by using a prior knowledge frame. Protocols of this type are rare in prose learning experiments with well-organized text, college subjects, and immediate free recall conditions, but extremely interesting in showing the learner's contribution to learning and memory.

The final protocol was written by a 70-year-old female with a high school education and average verbal ability immediately after reading the Saint text.

Recall Protocol 0 1

They put their faith in prayer. In all three instances they were on their deathbed and after they prayed they attributed getting well to faith and incessant prayer to Bishop Newmann.

If you pray faithfully, put faith in it, your prayers are answered. I don't remember exactly each instance, but in each instance they were really sick and the only answer to their hope was prayer.

Three points (10%) were scored on the Kintsch structure in Figure 5, while 24 points (27%) were given in Figure 6. In the Meyer system, the correct relationships can be credited even though there are few accurate specifics.

In summary, the Kintsch scoring system is more efficient for scoring immediate free recall protocols with close correspondence to text content. The Meyer approach is more time consuming, but more effective with less accurate recall protocols. When studying delayed recall, recall of older adults, children, and less proficient learners, it would be advantageous to use the Meyer approach. Bieger and Dunn (Note 3) found this in their study of children; the Meyer approach could identify developmental differences in children which could not be detected with the less sensitive procedure. Also, for studying recall of older adults, particularly those with lower education and verbal levels, the Meyer approach would be more satisfactory. As seen from protocol O 1, the Kintsch approach would record little information about recall of this type of older adult. In addition, the underlying logic processed by learners from expository text is better studied with the Meyer system. Also, the organization (top-level structure) in the text and in the recall protocol has been studied reliably with the Meyer approach (see scoring in Appendix).

Purposes and Problems

In the beginning of this chapter, it was explained that identification of the structure of text is a necessary methodological tool for (1) scoring recall from text, (2) generating models of text memory and examining variations between the models and the structure and content contained in reader's recall protocols, and (3) identifying significant dimensions on which texts differ to clarify limits in generalizing experimental

results. Two prose analysis procedures have been examined in depth on the issue of scoring; both provide reliable and useful scoring methods. Selection of a procedure depends on the type of subjects studied and the research questions asked. The Meyer approach, with the scoring of top-level structure in text and protocol and discrete scoring of relations and content, can better examine variations between the text and the reader's memory of it. Both approaches have a need to account for prior knowledge schemata and their interaction with the text.

Progress has only begun on the problem of identifying significant dimensions on which texts differ. The work on different discourse types has been discussed previously. Meyer and Rice (Note 5) have recently collected some interesting data related to Brewer's (1980) distinction between the time series thrust of narration and the logical thrust of exposition.

Meyer and Rice had 300 young, middle, and old adults read and immediately free recall the supertanker passage (see Appendix) and a passage of comparable length, levels, number of idea units, and number of details on the topic of railroads. The passage explained that businessmen favored the early development of the railroad and took steps to promote its development. Then, a brief history of railroad development was given. Finally, a brief description was given about different groups of people who opposed railroad development. Five versions of each passage were written (see Table 2). Two versions signaled the superordinate logical structure of the text (i.e., included all the signaling words listed in the content structure of the Appendix); one version contained 22 specific names, dates, and numbers at the lowest level in the content structure and the other did not. For the version without specific details general

terms were substituted (i.e., THOUSANDS for 200,000 and YEARS AGO for 1975). The other three versions did not signal the logical structure of the texts; one non-signaled version contained the details, one did not, and the third contained both details and signaling which emphasized these details (i.e., disastrous year of 1967).

The interesting finding for this discussion is that the manipulations differentially affected the two passages. For the supertanker passage, signaling increases recall of the superordinate logical relations and facilitates high usage of the problem/solution structure by subjects to organize their recall protocols. The levels effect is present for all versions of the passage for all age groups of adults. As seen in Table 2, without signaling the information at the highest level, which includes these signaled or non-signaled relationships, becomes equivalent in recall to the next highest structural level; both the high and medium high levels surpass recall of the next two levels. Evidently, having to make inferences to identify the logic of the text reduces the probability of its recall which, in turn, reduces the recall of levels 1-4 in the content structure. The detail manipulation appears to have little effect on the levels effect or organization of recall protocols for the supertanker passage.

In contrast, both the signaling manipulation and the detail manipulation have large effects on these dependent variables for the railroad passage. As seen in Table 2, only one version shows the expected levels effect and high use of the comparison top-level structure in recall protocols; this is the version with signaled logical relations and no specific details. Moderate use of the comparison top-level structure and some

levels effects occur for the conditions which change either one of these conditions; that is, signaling of the logic and specific details or no signaling and no details. No levels effects and relatively low structure use for adults (Meyer, in press) result in the two conditions without signaling of the logical relations and addition of details. In fact, for these two versions, the lowest level (7-9) of structural information is recalled better than levels 1-6.

The reason for the differential effect of these manipulations for the two passage appears to lie in Brewer's (1980) discourse type differentiation. The supertanker text is a typical expository text; it presents logic to inform and persuade. However, the railroad text is a history with superordinate causal and descriptive relations and a comparison top-level structure. The original version of this text came from a ninth-grade social studies book (Bartlett, 1978). Histories fall under Brewer's narrative discourse type. By signaling the logical relations in the railroad text, we emphasize the logic and may force a narrative (top-level structure of collection with a time line) into an expository format. By taking away the signals and leaving the details, the subjects may now process the text with their narrative schema, a collection of events on a time line. Signaling the logical structure and taking away the specific dates which tie down the time line allows subjects to process the text as an exposition; that is, they search for the logical structure to organize the text rather than utilize the narrative schema. Thus, the conditions in Table 2 without signaling of the text's logic and with details reorder the entire content structure.

Figures 9 and 10 show the different top-level structures for the railroad content when it is processed as expository text (Figure 9) and when it is processed as narrative text (Figure 10). Note the location of the dates in the two figures. For the comparative, expository processing schema (Figure 9), the dates are the lowest level of the text; this is the schema thought to be utilized by the readers in the second condition listed in Table 2, signal logic, remove specific details. Here the levels effect is found. For the narrative processing schema (collection of descriptions on a time line, see Figure 10), the dates are high in the structure; this is the schema considered to be in operation for the third and fourth conditions listed in Table 2, no signaling of logic, addition of specific dates and details.

Characterizing text on the basis of discourse type, emphasis of logical structure, and amount and kind of details appear to be important steps in differentiating among text selections. An example of generalization problems for interpreting the research literature comes from an aging study with Meyer's (1975) passage entitled PARAKEETS: IDEAL PETS. Zelinski, Gilewski, and Thompson (1980) shortened the text by deleting levels 9-14 in the content structure; they found no age differences for levels 1 and 2 but reported deficits for recall of the details. Meyer and Rice (in press) used the entire text to study age differences; they found no deficit in recall of the highest levels in the structure, but found older adults recalled more specific details (levels 9-14) than young adults. The older adults recalled fewer major details which supported the logic of the text (levels 6-8). Thus, a review (Hartley, Harker, & Walsh, 1980) explained that one study (Zelinski et al., 1980) found deficits in old

adults' recall of details, while another study (Meyer & Rice, in press) reported superiority in recall of details by older adults. Analysis of the types of details used in the two studies revealed agreement of findings rather than disagreement. This resolution was possible since versions of the same passage were used; the problem would not be as easily resolved with different texts.

In conclusion, a number of important steps have been made in the area of prose analysis. Methods for identifying text structure have resulted in an explosion of research in the area of prose learning. This research has increased to our understanding of processes involved in reading and writing. There are still a number of unresolved problems. However, the potential still appears great for this research area to continue in its contribution to our understanding of learning and memory.

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Table 1

Comparison of Strengths (+) for the Major Discourse Analysis Systems

Used in Educational Research Which Have Applicability to

Most Types of Classroom Learning Materials

Analysis Systems	Overall Structure: Articulation & Classification	Hierarchical Structure: Reflection of Subordination & Text Based Importance	Logical Relations: Examine & Score	Finer Distinctions: Semantic & Causal Relations; Substantive Recall	Learning Time: Simplicity	Speed in Scoring
Frederiksen			+	+		
Kintsch		+			+	+
Meyer	+	+	+			

Table 2

Changes in Levels Effect and Organization of Recall Protocols with Variations in Signaling the Text's Logical Structure and Emphasis and Addition of Details

Signal Logical Relations	Add Specific Dates & Details	Comparison, History of Railroads Text		Problem/Solution Supertanker Text	
		Levels Effect	Use of Comparison Top-Level Structure in Ss' Recall Protocols	Levels Effect	Use of Problem/Solution Top-Level Structure in Ss' Recall Protocols
Signal	Details	Some Levels Effect (Y[2]: H > L > MH > ML; M: L > H = MH > ML; O: H > ML = L = MH)	Moderate Use (72%)	Levels Effect (H[1] > MH > ML > L)	Very High Use (93%)
Signal	No Detail	Levels Effect (H > MH > ML > L)	High Use (80%)	Levels Effect (H > MH > ML > L)	Very High Use (92%)
No Signal	Signal Details	No Levels Effect (L > H = MH = ML)	Low Use (60%)	Some Levels Effect (H = MH > ML > L)	Moderate Use (78%)
No Signal	Details	No Levels Effect (L > H = ML = MH)	Low Use (68%)	Some Levels Effect (H = MH > ML > L)	High Use (85%)
No Signal	No Details	Some Levels Effect (Y: H = MH = ML > L; M: H > ML = MH > L; O: H > MH > ML > L)	Moderate Use (78%)	Some Levels Effect (H = MH > ML > L)	High Use (88%)

[1] H = Highest Levels in Content Structure, Levels 1-4
MH = Medium High, Level 5
ML = Medium Low, Level 6
L = Low, Levels 7-9

[2] Y = young adults 18-32
M = middle adults 40-54
O = old adults 65-up

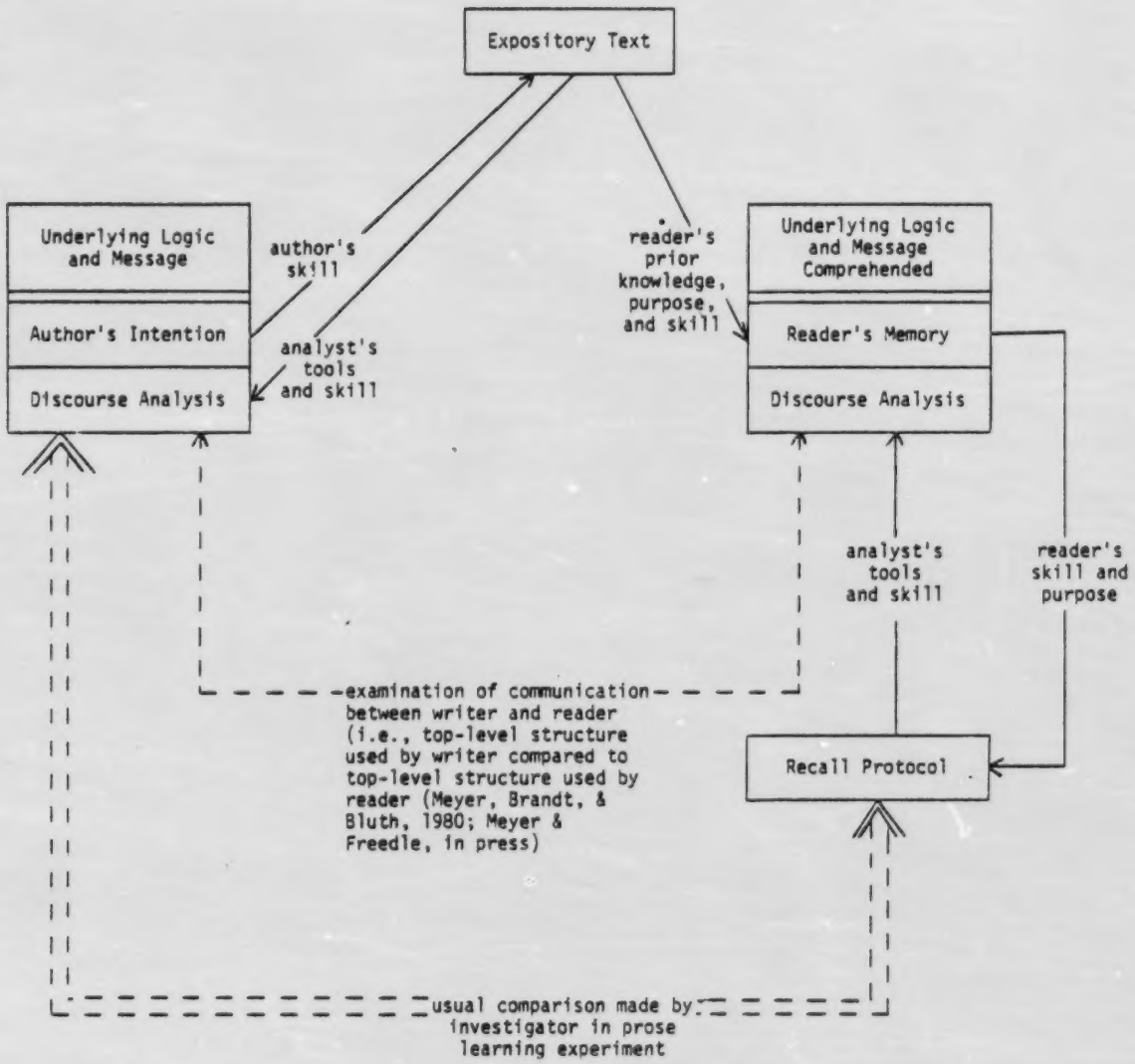

Expository Text
Underlying Logic and Message
Author's Intention
Discourse Analysis
author's skill
analyst's tools and skill
reader's prior knowledge, purpose, and skill
Underlying Logic and Message Comprehended
Reader's Memory
Discourse Analysis
analyst's tools and skill
reader's skill and purpose
examination of communication between writer and reader (i.e., top-level structure used by writer compared to top-level structure used by reader (Meyer, Brandt, & Bluth, 1980; Meyer & Freedle, in press)
Recall Protocol
usual comparison made by investigator in prose learning experiment

Figure 1. Complexity of prose learning paradigm.

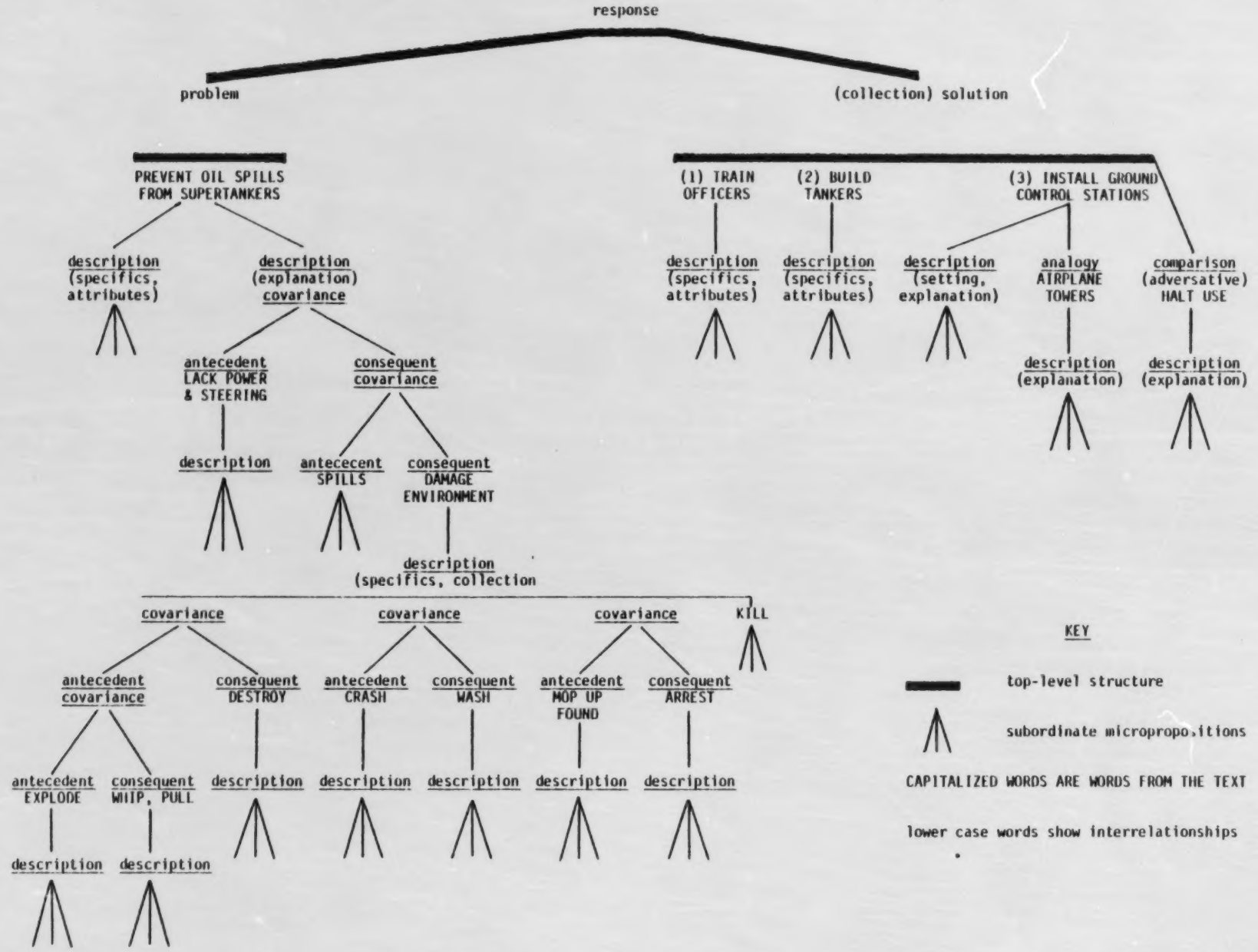
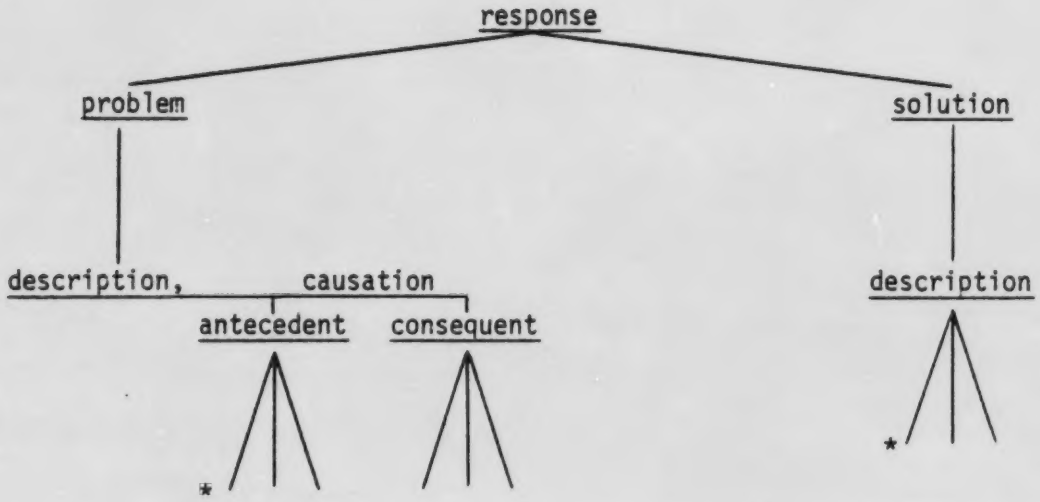


Figure 2. Superordinate structure of relationships of a magazine article on supertankers.

Figure 3. Continuum of argument constraints on which collection, causal, and response relations range.



*match must exist between at least one component of cause of problem and one component of possible solution.

Figure 4. Schematic diagram of required grammatic categories of expository text organized with problem/solution top-level structure.

Recall Data of Miller & Kintsch (1980)	Subjects							Text Base
	I13	I7	D7	I5	D5	D41	O1	
101	1	1	1	1	0	1	0	(P 1 (REQUEST P2 P8))
102	1	1	1	1	1	1	0	(P 2 (CANONIZE P3))
90	1	1	1	0	0	0	0	(P 3 (ISA JOHN-NEWMANN FRONTIER-PRIEST))
93	1	1	1	0	0	0	1	(P 4 (ISA JOHN-NEWMANN BISHOP))
86	1	1	1	0	0	0	0	(P 5 (LOC: IN P4 PHILADELPHIA))
60	0	1	0	0	0	0	0	(P 6 (TIME: IN P4 19TH-CENTURY))
110	1	1	0	0	0	0	0	(P 7 (TWO MIRACLES))
104[1]	1	1	0	0	0	0	0	(P 8 (ATTRIBUTED P7 JOHN-NEWMANN))
—	0	0	0	0	0	0	0	(P 9 (TIME: IN P8 THIS CENTURY))
								SENTENCE
82	0	1	0	0	0	0	0	(P10 (TIME: IN P11 1923))
69	1	1	0	0	0	0	0	(P11 (DYING EVA-BENASSI PERITONITIS))
	0	0	0	0	0	0	0	(P12 (DRAMATICALLY P13))
114	1	1	0	0	0	0	0	(P13 (RECOVERED EVA-BENASSI))
111	1	1	0	0	0	1	1	(P14 (AFTER P15 P13))
83	1	1	0	0	0	0	0	(P15 (PRAYED NURSE BISHOP))
								SENTENCE
77	1	1	0	0	0	0	0	(P16 (TIME: IN P17 1949))
	1	0	0	0	0	0	0	(P17 (HOSPITALIZED KENT-LENAHAN P18 P20 P21))
93	0	1	0	0	0	0	0	(P18 (FRACTURES SKULL KENT-LENAHAN))
63	0	1	0	0	0	0	0	(P19 (TWO P18))
74	0	1	0	0	0	0	0	(P20 (SMASHED BONES KENT-LENAHAN))
86	1	0	0	0	0	0	0	(P21 (PIERCED LUNG KENT-LENAHAN))
80	1	0	0	0	0	0	0	(P22 (AFTER P17 ACCIDENT))
56	1	0	0	0	0	0	0	(P23 (TRAFFIC ACCIDENT))
59	1	1	0	0	0	0	0	(P24 (ROSE KENT-LENAHAN DEATHBED))
98	1	1	0	0	0	0	0	(P25 (RESUMED KENT-LENAHAN P26))
97	1	1	0	0	0	0	0	(P26 (NORMAL LIFE)
104	1	1	0	0	0	1	1	(P27 (AFTER P25 P28))
28	1	1	0	0	0	0	0	(P28 (PRAYED MOTHER JOHN-NEWMANN)
—	0	1	0	0	0	0	0	(P29 (ARDENTLY P28))
								SENTENCE
	22	23	5	2	1	4	3	Total Recall

[1]Excluded by Miller & Kintsch.

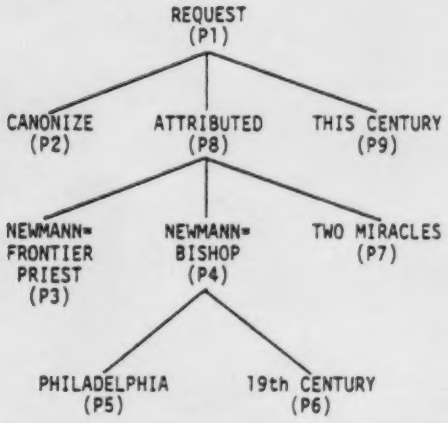
Figure 5. Kintsch analysis of "Saint" text used by Miller and Kintsch (1980) and scoring of sample protocols.

Subjects								Content Structure
I13	I7	D7	I5	D5	D41	O1		
1	1	0	0	0	0	0	1	WERE ATTRIBUTED
1	1	0	0	0	0	0	2	setting location
1	1	1	1	0	1	0	3	REQUEST
1	1	1	1	0	1	0	4	patient
1	1	1	1	1	1	0	5	CANONIZE
1	1	1	1	1	1	0	6	patient
1	1	1	0	0	0	0	7	FRONTIER PRIEST
1	1	1	0	0	0	0	8	equivalent
1	1	1	1	1	0	0	9	JOHN NEWMANN
1	1	0	0	0	0	0	10	benefactive
1	1	1	0	0	0	1	11	JOHN NEWMANN
1	1	1	0	0	0	1	12	attribution
1	1	1	0	0	0	1	13	WAS BISHOP
1	1	1	0	0	0	0	14	range
1	1	1	0	0	0	0	15	PHILADELPHIA
0	1	0	0	0	0	0	16	setting time
1	1	0	0	0	0	0	17	19th CENTURY
1	0	0	0	0	0	0	18	setting time
0	0	0	0	0	0	0	19	THIS CENTURY
1	1	0	0	0	0	0	20	patient
1	1	0	0	0	0	0	21	MIRACLES
1	1	0	0	0	0	0	22	specific
1	1	0	0	0	0	1	23	collection (TWO)
1	1	1	0	0	1	1	24	covariance, consequent (24, 36)
1	1	0	0	0	1	1	25	RECOVERED
1	1	0	0	0	0	0	26	setting time
1	1	0	0	0	0	0	27	1923
1	1	0	0	0	0	1	28	patient
1	1	1	0	1	0	0	29	EVA BENASSI
1	1	0	0	0	0	0	30	attribution
1	0	0	0	0	0	1	31	DYING
1	0	0	0	0	0	0	32	force
1	1	0	0	0	0	0	33	PERITONITIS
0	0	0	0	0	0	0	34	manner
0	0	0	0	0	0	0	35	DRAMATICALLY
1	1	1	0	0	1	1	36	covariance, antecedent (24, 36)
1	1	1	0	0	1	1	37	PRAYED
1	1	1	0	0	1	1	38	agent, former
1	1	0	0	0	0	0	39	NURSE
1	1	0	0	0	0	0	40	specific
1	1	0	0	0	0	0	41	HER (EVA BENASSI'S NURSE)
1	1	0	1	0	0	1	42	range, latter
1	1	0	0	0	1	1	43	BISHOP (JOHN NEWMANN)
1	1	0	0	0	1	1	44	covariance, consequent (44, 81)
1	1	0	0	0	0	0	45	collection
1	1	1	0	0	0	0	46	ROSE
1	1	0	0	0	0	0	47	setting time
1	1	0	0	0	0	0	48	1949
0	1	1	0	0	0	0	49	patient
1	1	0	0	0	0	0	50	KENT LENAHAN

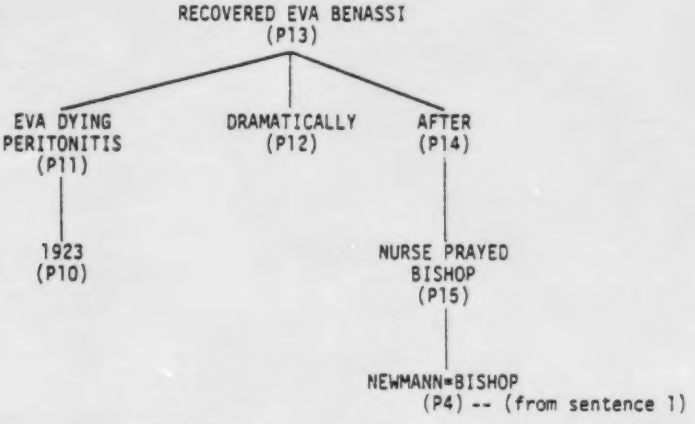
Subjects								Content Structure
I13	I7	D7	I5	D5	D41	O1		
1	1	0	0	0	0	0	51	attribution
1	1	0	0	0	0	0	52	covariance, consequent (68, 52)
1	0	1	0	0	0	0	53	HOSPITALIZED
1	0	1	0	0	0	0	54	patient
1	1	0	0	0	0	0	55	KENT LENAHAN
1	1	0	0	0	0	0	56	attribution
1	1	0	1	0	0	0	57	collection
1	1	0	1	0	0	0	58	FRACTURES
1	1	0	1	0	0	0	59	specific
0	1	0	0	0	0	0	60	TWO
0	1	0	1	0	0	0	61	SKULL
0	1	0	0	0	0	0	62	SMASHED
0	1	0	0	0	0	0	63	patient
0	1	0	0	0	0	0	64	BONES
1	0	0	0	0	0	0	65	PIERCED
1	0	0	0	0	0	0	66	patient
1	0	0	1	0	0	0	67	LUNG
1	1	0	0	0	0	0	68	covariance, antecedent (52, 68)
1	1	0	0	0	0	0	69	ACCIDENT
1	0	0	0	0	0	0	70	specific
1	0	0	0	0	0	0	71	TRAFFIC
1	1	1	0	0	0	0	72	range
1	1	1	0	0	0	1	73	DEATHBED
1	1	0	0	0	1	1	74	RESUMED
1	1	0	0	0	1	0	75	agent
1	1	0	0	0	0	0	76	KENT LENAHAN
1	1	0	0	0	1	1	77	patient
1	1	0	0	0	1	1	78	LIFE
1	1	0	0	0	0	0	79	specific
1	1	0	0	0	0	0	80	NORMAL
1	1	0	0	0	1	1	81	covariance, antecedent (44, 81)
1	1	0	0	0	1	1	82	PRAYED
1	1	0	0	0	1	1	83	agent, former
1	1	0	0	0	0	1	84	MOTHER
1	1	0	0	0	0	1	85	specific
1	1	0	0	0	0	1	86	HIS (KENT LENAHAN'S)
0	1	0	0	0	0	0	87	manner
0	1	0	0	0	0	0	88	ardently
1	1	0	0	0	0	1	89	range, latter
1	1	0	0	0	0	1	90	NEWMANN
78	77	20	16	4	19	64	Total Recall	

Figure 6. Meyer analysis of "Saint" text by Miller and Kintsch (1980) and scoring of sample protocols.

Sentence 1:



Sentence 2:



Sentence 3:

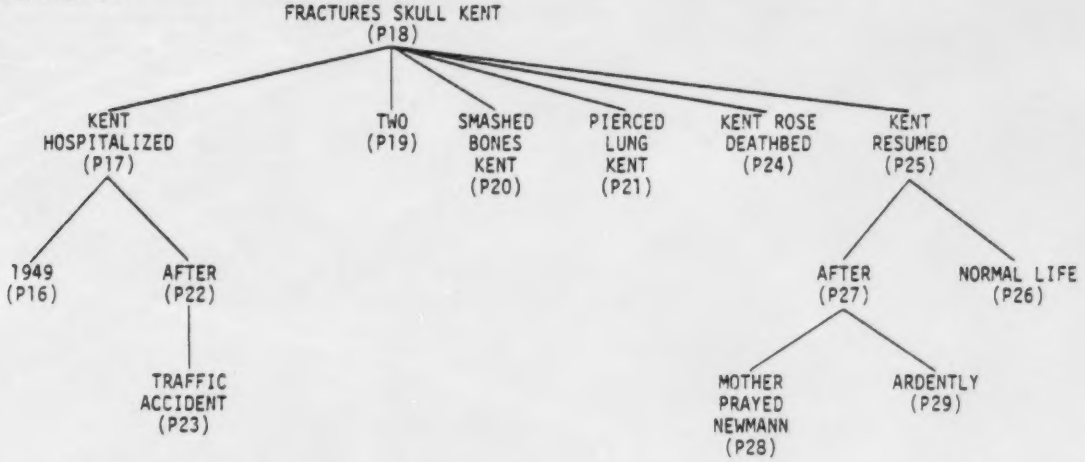


Figure 7. Kintsch (Miller & Kintsch, 1980) level analysis of their "Saint" text (numbers correspond to propositions in Figure 2).

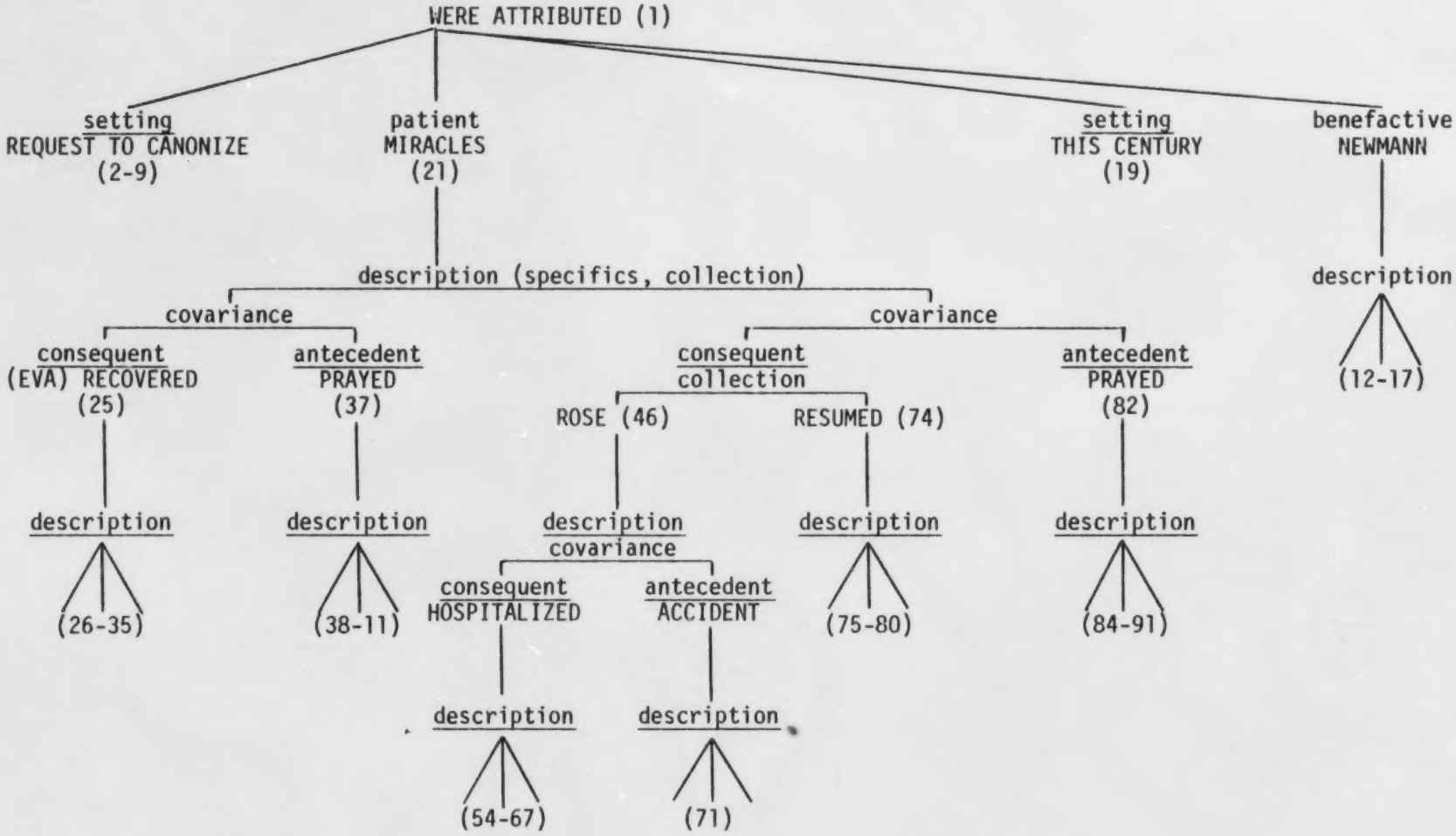


Figure 8. Superordinate structure of relationships of "Saint" text (Miller & Kintsch, 1980) from Meyer approach (numbers correspond to content and relationships in Figure 1).

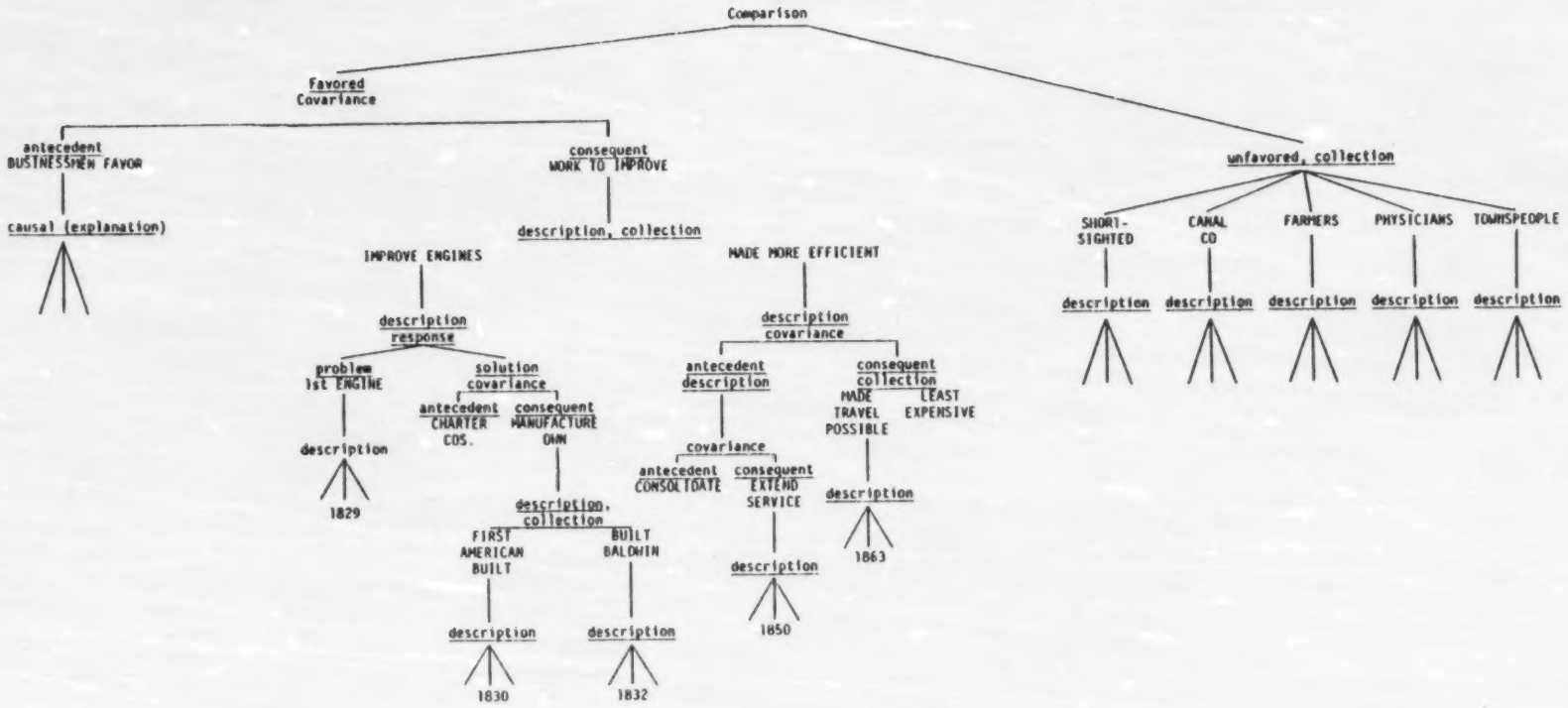


Figure 9. Railroad superordinate structure analyzed as expository text.

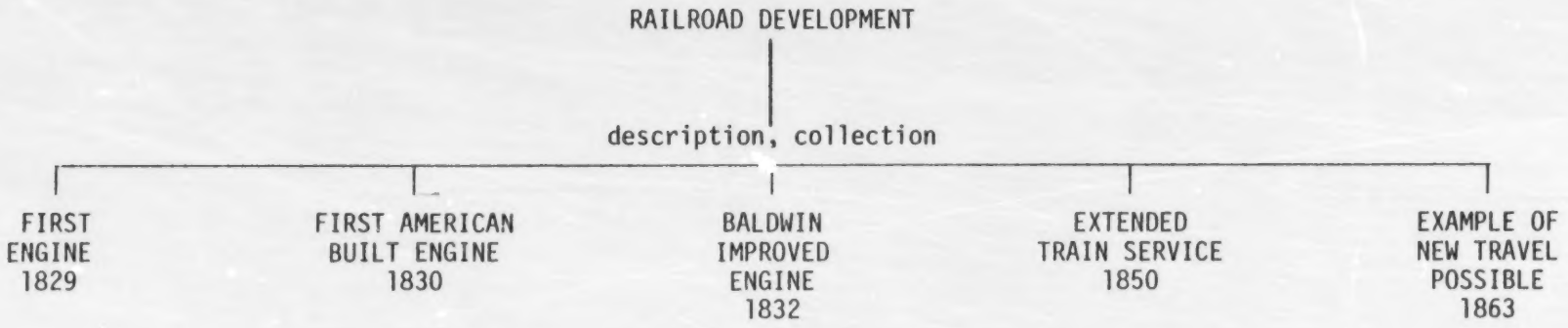


Figure 10. Narrative schema applied to the railroad text.

APPENDIX

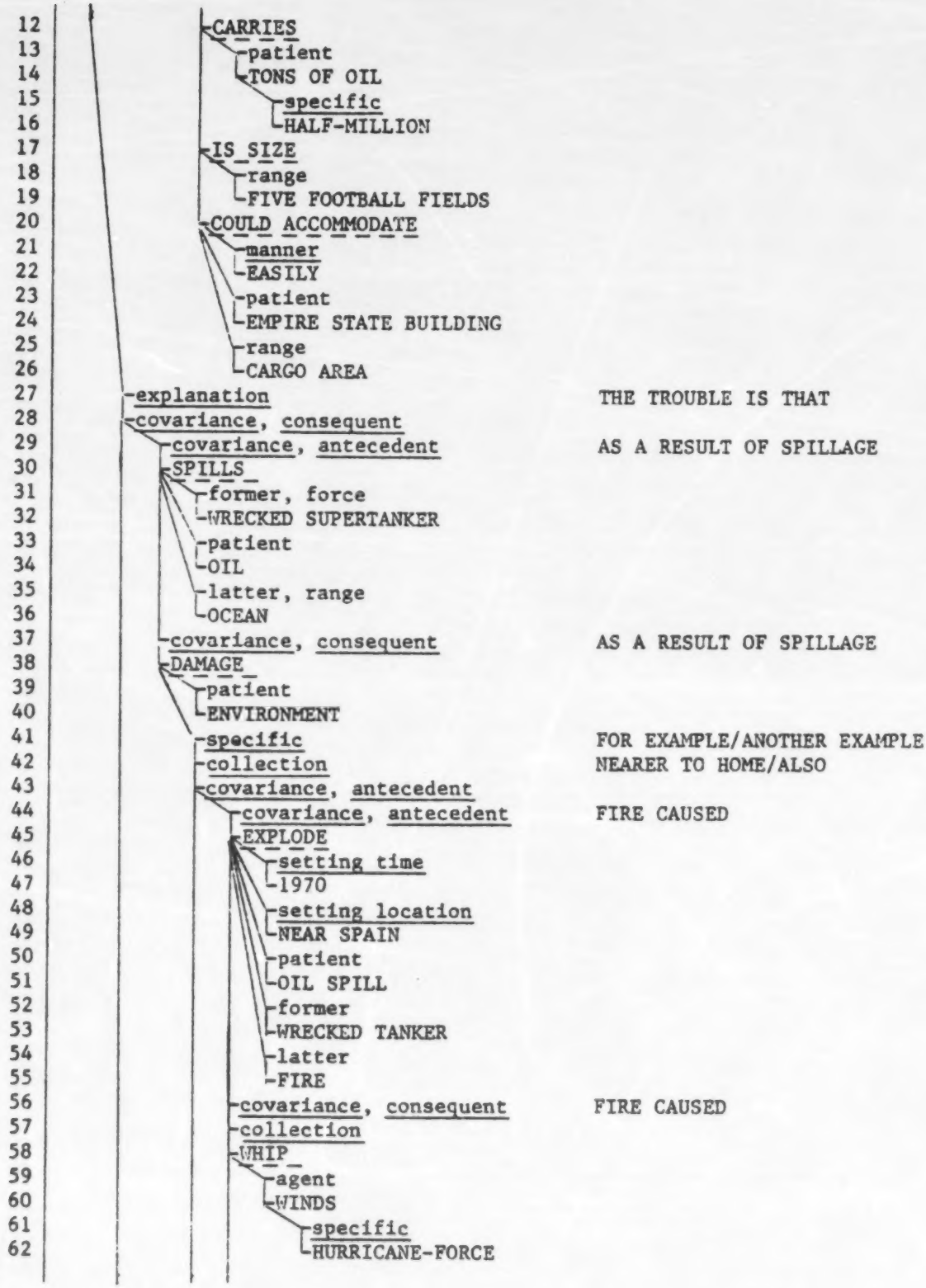
SOME SOLUTIONS FOR THE SUPERTANKER PROBLEM

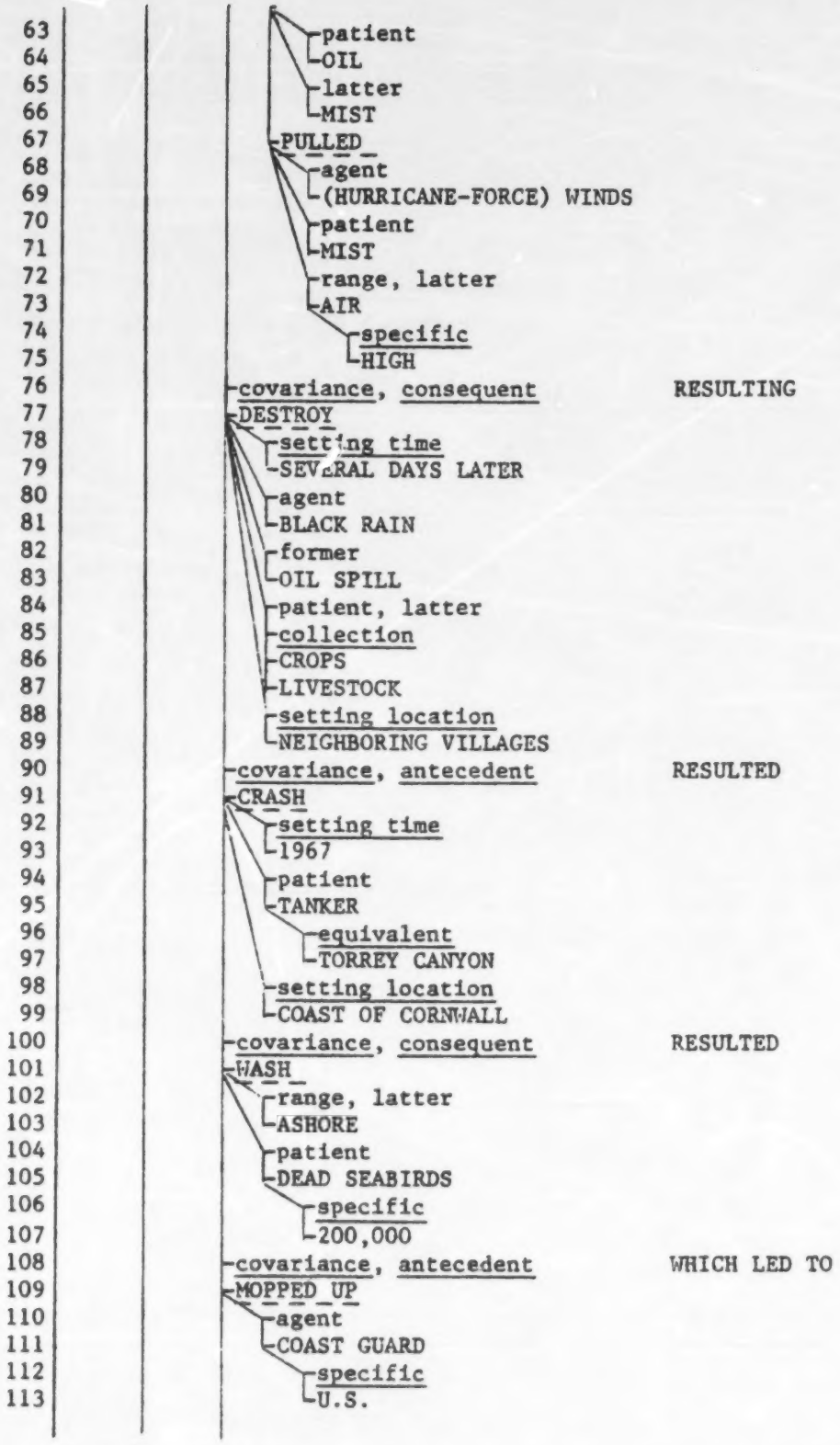
A problem is prevention of oil spills from supertankers. Attributes of a typical supertanker include the following: it carries a half-million tons of oil; it is the size of five football fields; it could accommodate easily the Empire State Building in its cargo area. The trouble is that a wrecked supertanker spills oil in the ocean. As a result of this spillage, the environment is damaged. An example took place in 1970 near Spain when an oil spill from a wrecked tanker exploded into fire. The fire caused hurricane-force winds which whipped the oil into a mist and pulled all of it high into the air. Several days later black rain resulting from this oil spill destroyed crops and livestock in the neighboring villages. Another example of damage occurred in 1967 when the tanker, Torrey Canyon, crashed off the coast of Cornwall and resulted in the washing ashore of 200,000 dead seabirds. An example which happened nearer to home came to pass in July 1975 when the United States Coast Guard mopped up acres of oil from the beach at Geiger Key, Florida, north of Key West. Guardsmen found chemical clues which led to the arrest on November 7, 1975 of a Greek tanker captain, Vasilios K. Psarroulis, because of failure to report the loss of an estimated 40,000 gallons of oil. Oil spills also kill microscopic plant life which provide food for sea life and produce 70 percent of the world's oxygen supply.

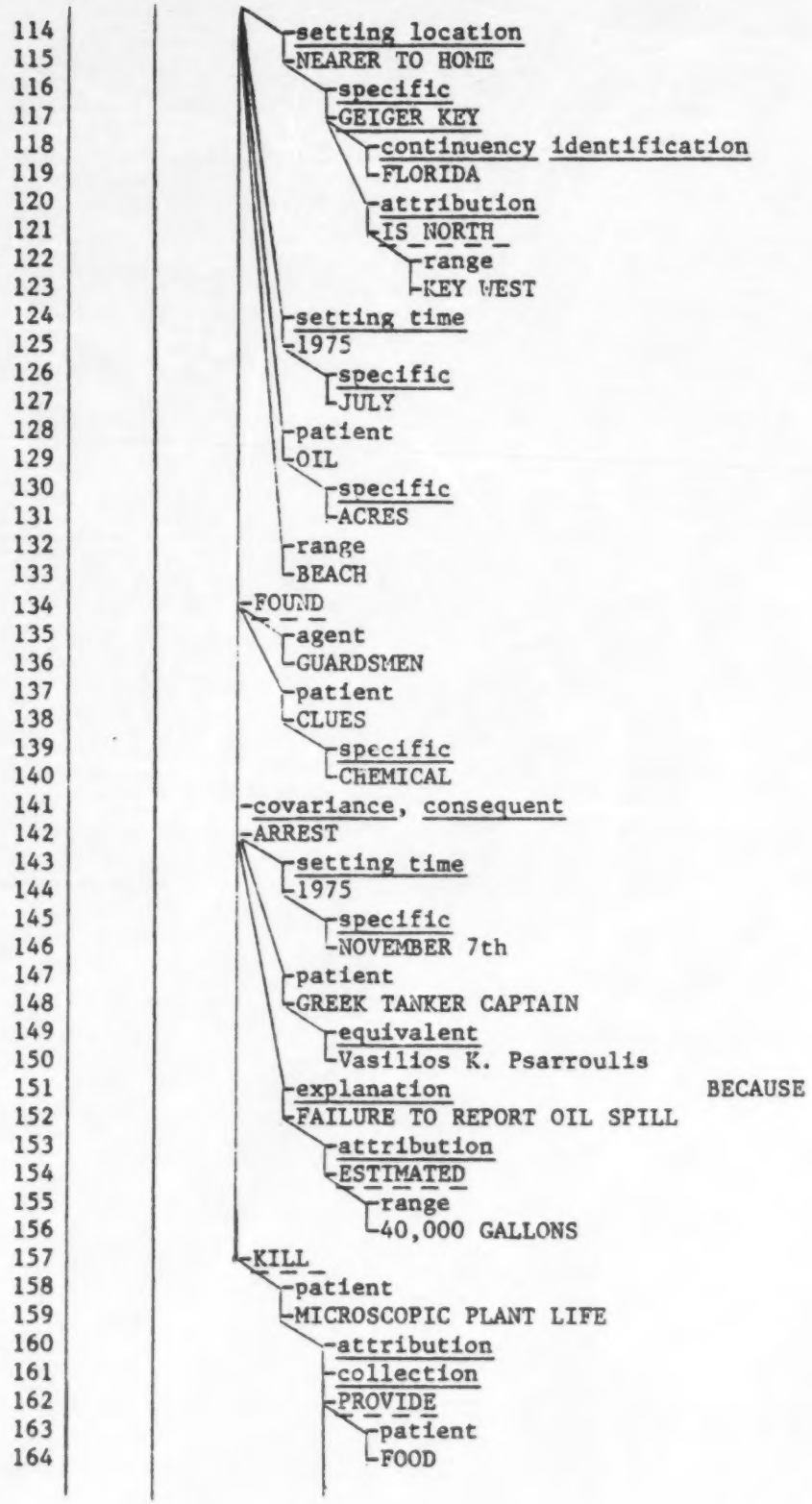
Oil spills result from the lack of power and steering equipment to handle emergency situations, such as storms. Supertankers have one boiler to provide power and one propeller to steer the ship.

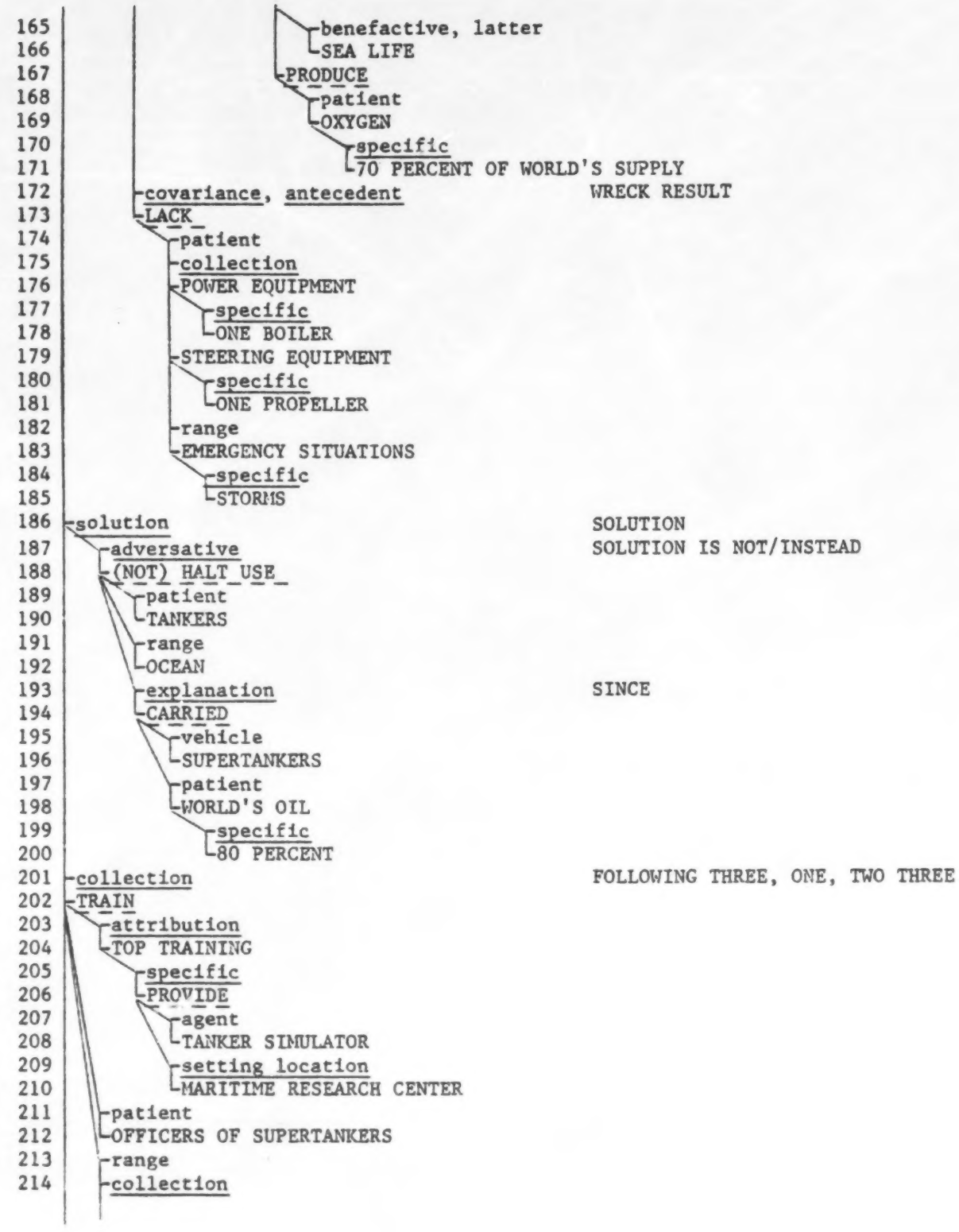
The solution to the problem is not to halt the use of tankers on the ocean since about 80 percent of the world's oil supply is carried by supertankers. Instead, the solution lies in the following three tactics. First, officers of the supertankers must be trained in how to run and maneuver their ships; this training must be top training, such as that provided by the tanker simulator at the Maritime Research Center. Second, tankers should be built with several propellers for extra control and backup boilers for emergency power. Third, ground control stations should be installed at places where supertankers come close to shore; they would act like airplane control towers. The ground control stations would guide tankers along busy shipping lanes and through dangerous channels.

Content Structure	SIGNALING OF RHETORICAL STRUCTURE:
1 response	PROBLEM/SOLUTION
2 problem	PROBLEM
3 PREVENT	
4 patient	
5 OIL SPILL	
6 former	
7 SUPERTANKERS	
8 representation identification	TYPICAL
9 SUPERTANKER	
10 attribution	
11 collection	


CARRIES
patient
TONS OF OIL
specific
HALF-MILLION
IS_SIZE
range
FIVE FOOTBALL FIELDS
COULD ACCOMMODATE
manner
EASILY
patient
EMPIRE STATE BUILDING
range
CARGO AREA
explanation
THE TROUBLE IS THAT
covariance, consequent
covariance, antecedent
AS A RESULT OF SPILLAGE
SPILLS
former, force
WRECKED SUPERTANKER
patient
OIL
latter, range
OCEAN
covariance, consequent
AS A RESULT OF SPILLAGE
DAMAGE
patient
ENVIRONMENT
specific
FOR EXAMPLE/ANOTHER EXAMPLE
collection
NEARER TO HOME/ALSO
covariance, antecedent
covariance, antecedent
FIRE CAUSED
EXPLODE
setting time
1970
setting location
NEAR SPAIN
patient
OIL SPILL
former
WRECKED TANKER
latter
FIRE
covariance, consequent
FIRE CAUSED
collection
WHIP
agent
WINDS
specific
HURRICANE-FORCE


patient
OIL
latter
MIST
PULLED
agent
(HURRICANE-FORCE) WINDS
patient
MIST
range, latter
AIR
specific
HIGH
covariance, consequent
RESULTING
DESTROY
setting time
SEVERAL DAYS LATER
agent
BLACK RAIN
former
OIL SPILL
patient, latter
collection
CROPS
LIVESTOCK
setting location
NEIGHBORING VILLAGES
covariance, antecedent
RESULTED
CRASH
setting time
1967
patient
TANKER
equivalent
TORREY CANYON
setting location
COAST OF CORNWALL
covariance, consequent
RESULTED
WASH
range, latter
ASHORE
patient
DEAD SEABIRDS
specific
200,000
covariance, antecedent
WHICH LED TO
MOPPED UP
agent
COAST GUARD
specific
U.S.


setting location
NEARER TO HOME
specific
GEIGER KEY
continuency identification
FLORIDA
attribution
IS NORTH
range
KEY WEST
setting time
1975
specific
JULY
patient
OIL
specific
ACRES
range
BEACH
FOUND
agent
GUARDSMEN
patient
CLUES
specific
CHEMICAL
covariance, consequent
ARREST
setting time
1975
specific
NOVEMBER 7th
patient
GREEK TANKER CAPTAIN
equivalent
Vasilios K. Psarroulis
explanation
BECAUSE
FAILURE TO REPORT OIL SPILL
attribution
ESTIMATED
range
40,000 GALLONS
KILL
patient
MICROSCOPIC PLANT LIFE
attribution
collection
PROVIDE
patient
FOOD


benefactive, latter
SEA LIFE
PRODUCE
patient
OXYGEN
specific
70 PERCENT OF WORLD'S SUPPLY
covariance, antecedent
WRECK RESULT
LACK
patient
collection
POWER EQUIPMENT
specific
ONE BOILER
STEERING EQUIPMENT
specific
ONE PROPELLER
range
EMERGENCY SITUATIONS
specific
STORMS
solution
SOLUTION
adversative
SOLUTION IS NOT/INSTEAD
(NOT) HALT_USE
patient
TANKERS
range
OCEAN
explanation
SINCE
CARRIED
vehicle
SUPERTANKERS
patient
WORLD'S OIL
specific
80 PERCENT
collection
FOLLOWING THREE, ONE, TWO THREE
TRAIN
attribution
TOP TRAINING
specific
PROVIDE
agent
TANKER SIMULATOR
setting location
MARITIME RESEARCH CENTER
patient
OFFICERS OF SUPERTANKERS
range
collection

```
215 |  |-run
216 |  |-MANEUVER
217 |  |-benefactive
218 |  |-SHIPS
219 |-BUILD
220 |  |-patient
221 |  |-TANKERS
222 |  |  |-attribution
223 |  |  |-collection
224 |  |  |-SEVERAL PROPELLERS
225 |  |  |  |-explanation
226 |  |  |  |-EXTRA CONTROL
227 |  |  |-BACK-UP BOILERS
228 |  |  |  |-explanation
229 |  |  |  |-EMERGENCY POWER
230 |-INSTALL
231 |  |-patient
232 |  |-GROUND CONTROL STATIONS
233 |  |-setting location
234 |  |-PLACES WHERE SUPERTANKERS COME CLOSE TO SHORE
235 |  |-analogy                                    ACT LIKE
236 |  |-AIRPLANE CONTROL TOWERS
237 |  |-explanation                                BECAUSE
238 |  |-GUIDE
239 |  |  |-patient
240 |  |  |-TANKERS
241 |  |  |-range
242 |  |  |-collection
243 |  |  |-ALONG BUSY SHIPPING LANES
244 |  |  |-THROUGH DANGEROUS CHANNELS
```

Rules to Guide Scoring of Free Recall Protocols

Purpose for Scoring: ascertain S's recall of meaning the text is attempting to get across; (a) recall of topic content, and (b) recall of relationships (text-based: explicit or implicit) among aspects of the topic content

Score as present in protocol the following:

(1) Verbatim recall of topic content: referential indices and lexical predicates.

(2) Substantive recall of topic content: referential indices and lexical predicates

judgment is required here--any reasonable paraphrase in terms of general meaning should be counted in scoring

scorers may have to come to joint agreement on limits for acceptable paraphrases - particularly for referential indices which could be analyzed more minutely but haven't; such as microscopic plant life (could be further analyzed to life - specific plant - specific microscopic) (we opted in our study to require some indication of small plant life for credit)

text	Scored as substantive recall
TOP (TRAINING)	any positive quality given to describe training
BLACK RAIN (black due to oil)	rain of oil
SEA LIFE	fish
FAILURE TO REPORT OIL SPILL	illegal spillage
HALF-MILLION TONS	hundreds of thousands of tons

(3) Role relationships are scored only when the lexical predicate dominating it is also scored; however the topic content (referent) it relates to the lexical predicate need not be scored if it does not meet requirements 1 & 2.

(4) Lexical predicates are scored much more loosely than other content words due to rule 3 above and their purpose of showing correct interrelationships rather than representing referents of topic content.

Lexical predicates can be scored present in a protocol on the basis of rules 1 and 2 and also rule 4.

4: Score present if (a) at least two referential indices (topic content) are correctly scored in the particular lexical proposition in the content structure, (b) these referential indices are related by the lexical predicate in question in exactly the same manner as they are related by the lexical predicate in the content structure (one argument may be superordinate due to building the hierarchy, but would take same role if sentence were analyzed in isolation); that is, they are interrelate on basis of the same role relationships--or more rarely rhetorical relationships, such as manner and settings.

Examples:

IS_NORTH_
- range
- Key West
- patient
- Geiger Key

Protocol: Geiger Key is by Key West
-all units scored as present

MOPPED_UP ✓
- setting location ✓
- GEIGER KEY ✓
- agent
- COAST GUARD
- patient ✓
- OIL ✓
- range
- BEACH

Protocol: Geiger Key was the location of another oil spill.

- units ✓ scored as present

(5) Rhetorical predicates are scored as present only if (a) the correct rhetorical relationship is signaled or implied in the protocol and (b) at least one of its arguments is scored as present in the protocol

Examples:

text structure	Protocol
LACK OF POWER EQUIPMENT CAUSES SPILLS	size causes spills (covariance) — scored as correct
APPLES, ORANGES, AND PEARS	apples and grapes — scored correct (collection)

(6) Circle in protocol, count, and record content units in the protocol which were not in the text; i.e., New England in "Birds washed ashore when oil tanker crashed off a (New England) shore." - compare with units 91-107 in content structure

(7) Circle in protocol, count, label (collection, causation, response, comparison, or description) logical relationship units in the protocol which were not in the text; i.e., causal relation not original text: "Spills are in part (due to) the large size of tankers - 5 football lengths." Compare with units 3-19, 28-36, 172-185 in content structure.

(8) Note on protocol and count the number of intra-text confusions; intra-text confusions are where content unit (referential index) from one lexical proposition is transposed and substituted for the correct content unit in another lexical proposition; i.e., "microscopic plant life produce 80% of the world's oxygen supply." Score as correct units 159, 160, 167, 168, 169, 170, and 200; they took the 80% from world's oil supply and confused it with the 70% oxygen supply.

(9) Score top-level structure of protocol

Scored as use of Response Top-Level Structure

1. Signal Problem and Solution and organized in problem/solution format
2. Signal only Solution and organized in problem/solution format
3. Signal only Problem and organized in problem/solution format
4. No Signal of Problem nor Solution, but implicit and organized in problem/solution format
5. Organized with other structure (comparison, description, causal), but state problem and solution sentences
6. Other structure organizes protocol and no mention of problem/solution
7. Collection, list overall organization, plus mentions problem/solution in sentences
8. Collection, list overall structure and no mention of problem/solution
9. Random list with no association for grouping

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